ELECTRICAL REVIEW

THE PIONEER ELECTRICAL WEEKLY OF AMERICA

VOL. XLVII. No. 23. NEW YORK, SATURDAY, DECEMBER 2, 1905. ISSUED WEEKLY

CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . MANAGING EDITOR

PUBLISHING OFFICE . . . . . 13-21 Park Row, New York
WESTERN OFFICE: Fisher Building, Chicago, Ill. . . . L. W. MARSHALL, Manager
BOSTON OFFICE: 161 Devonshire Street . . . . . M. W. BARBER, Manager
EUROPEAN OFFICE: 42 Old Broad Street, London, E. C. . . HENRY W. HALL, Manager

TELEPHONE "21 Cortlandt." Private exchange to all Departments.
REGISTERED CABLE ADDRESS: "Electview," New York.

TO ADVERTISERS

CHANGES for advertisements should be in this office by *Friday noon* for the following week's issue.
NEW ADVERTISEMENTS should be in the office not later than *Monday noon* to assure publication in that week's issue.

SUBSCRIPTIONS

One Year, United States and Canada $3.00
One Year, Foreign Countries 5.00
Single copy, 10 cents. Back numbers, beyond one month, each 25

CONTENTS.

EDITORIAL:
An Electrical Demonstration in Court 843
The Electrical Testing Laboratories 843
Telephone and Telegraph Troubles 844
The Gas Turbine Problem 845
The Telephone Pole 845
Report of the Commission on Electric Lighting for the City of New York 845
The Electrical Nature of Matter and Radioactivity, by Harry C. Jones 846
The Murgas System of Wireless Telegraphy, by Joseph Murgas 849
A Variable-Speed Steam Turbine 852
Construction of Canadian Niagara Power Company's 100,000-Horse-Power Hydroelectric Plant at Niagara Falls, Ontario, by Cecil B. Smith 852
Annual Meeting of the Underwriters' National Electrical Association 856
201st Meeting of the American Institute of Electrical Engineers 856
Report of the Commission on Electric Lighting for the City of New York 857
The New York Electrical Show 857
The Multiple Operation of Transformers, by R. T. MacKeen 858
Two Prominent Electrical Men Join Forces 860
Properties of Iron-Nickel-Manganese-Carbon Alloys 860
Mica—Its Occurrence, Exploitation and Uses 862
Municipal Ownership in Edinburgh, Scotland 864
A Large Electric Crane 864
ELECTRICAL PATENTS 865
REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE 866
A Suspended Electric Railway for Berlin 867
American Electrochemical Society 867
METHODS OF GETTING NEW BUSINESS 868
INDUSTRIAL SECTION:
Some Types of Machine-Motor Rheostats 869
4,500-Horse-Power Gas Plant in Cement Works 870
A Novel Water Hoist 870
The New Sangamo Alternating-Current Meter 872
New Municipal Electric Lighting Plant 873
A Tray Plate Spark Battery 873
CURRENT ELECTRICAL NEWS 874

AN ELECTRICAL DEMONSTRATION IN COURT.

An interesting illustration of the adaptability of electricity to demonstrating purposes occurred in the Superior Court room at Boston recently. The case of an Allston barber charged with stealing electricity from the Brookline Gas Company was being tried, and the prosecution, represented by Assistant District-Attorney Chase, desired to make the alleged offense clearer to the jury than was possible by ordinary diagrams and verbal explanations. A large board was displayed, containing a meter, a cut-out and a number of lights of different candle-power, supplied through a temporary circuit brought through a window. The witnesses claimed that the defendant loosened the neutral plug in his cellar cut-out, and thus put the meter out of business, restoring the plug prior to the arrival of the meter-readers. Check readings were obtained by placing a second meter on a pole in the barber's circuit outside his shop. The operation of the meter was thus shown experimentally to the jury, much in the way that some of the central-station companies exhibit meters to their customers and the general public. It is doubtful if any other form of energy could be so conveniently, cheaply, quickly and comfortably brought into court, and the use of electricity in this way went a long distance toward establishing the case of the prosecution.

THE ELECTRICAL TESTING LABORATORIES.

The recent meeting of the American Institute of Electrical Engineers has directed attention to certain institutions which are comparatively new in this country. The increasing use of electrical methods, the demand for greater uniformity of apparatus and instruments, and more accuracy in electrical measurements has created a need for bureaus at which instruments could be calibrated and special work done. This, as well as the need for standardization in other lines of scientific work, has resulted in the establishment of the National Bureau of Standards at Washington, D. C. The demand for a commercial institution where tests on apparatus in every-day use could be made quickly has brought forth the Electrical Testing Laboratories, of New York city. In other sections of the country the same need has led certain of the states to establish similar testing bureaus, where their citizens can resort for scientific and technical aid. The importance of exact knowledge regarding materials and apparatus is now being thoroughly appreciated, and the work of the engineer being greatly assisted by the data which these institutions are aiding him to obtain.

There are, however, a number of interesting questions which arise in considering these institutions. One point which was brought up was the effect, for example, of the Bureau of Standards upon the scientific work of the future, and, as an illustration, the work of Rowland was mentioned, in redetermining the mechanical equivalent of heat. The most elaborate and really the most important part of his work was preliminary to the actual determination. Much of this work would generally be considered drudgery, and it was said that such preliminary work to-day could be done by the Bureau of Standards, which would furnish an investigator with all the apparatus required for his research. Doubtless this is true, but one wonders whether it would be conducive to the best results. Delicate and accurate apparatus is not all that is needed for a successful experiment. Skill in the operator is just as requisite, and this can only be obtained when he is thoroughly familiar with his instruments, knows their faults and peculiarities, and how to get the best work out of them. It is in this work that the genius of the man appears, and it was this quality of Rowland that made him so successful. He knew intuitively the weak points of his method or instruments, and how to strengthen them. He could see at once just where the difficulty lay and how to get over it, even when he could not explain the trouble nor tell how he had eliminated it. Would a man of Rowland's type be satisfied to let some one else prepare all of his apparatus

for him? Would he not rather look upon the preliminary work as really the true work of the investigation, and the taking of the final readings almost as a secondary matter which any one might do after he had planned it and prepared the apparatus?

Of course, there is much work which can very properly be done by the Bureau of Standards. The production of apparatus for accurate calibration of apparatus, and the development of proper methods of constructing instruments and standards come under this head, and there will always be much purely scientific work which the bureau will have to do for itself, but one can not but feel that anyone who is carrying out an original investigation would prefer to design his own apparatus according to his own ideas, and have it built under his own eye. This does not reflect in any way upon the value of the bureau's work. It is merely a phase of scientific methods.

TELEPHONE AND TELEGRAPH TROUBLES.

The layman, and, indeed, a goodly number of engineers, have a fashion of looking on telephone and telegraph engineering as smaller professions, hardly deserving to be dignified as engineering. This is far from true, for the problems presented to the engineers of these two industries are as important and as difficult of solution as those confronting any other class. Telegraph engineers can point proudly to great names identified with their profession—names which will lose nothing when placed side by side with those of any other branch of engineering; yet in spite of this, there are to-day problems which have been with them for a long time, and on which much thought and even money have been expended.

Telephone engineers belong to a newer order of things. While, in some respects, they might be classified with the telegraph engineers, since both deal with systems of communication, the problems presented to them are of an entirely different character from those which the telegraph man contends with. They have come into prominence on account of the great extension of the use of the telephone. The ordinary telephone user probably thinks that the problem of verbal communication was solved once for all by Bell, and that the work to-day consists simply in placing instruments in different offices and running wires to a central point, so that the various subscribers can be put into communication. This does not at all represent the case, for many years were required after Bell first exhibited his system before entirely satisfactory receiving and transmitting apparatus were developed, and to-day it would be difficult to devise a more troublesome problem than is presented to the telephone engineer in designing a large central office. Where there are but a few circuits to be connected together, or even a few hundred circuits, the matter is comparatively simple, but when the number of circuits running into a station runs up to 20,000 or more, and means must be provided for connecting any one of these 20,000 or more circuits with any other one, and doing it quickly and surely, it is evident that the task is one of the greatest magnitude. It has, however, been satisfactorily solved by the rapid development of the telephone switchboard. So rapid has been the growth of the telephone that the needs of our larger cities make it necessary for the telephone companies serving them to build and equip several central offices, thus multiplying greatly the number of parts which must be kept in perfect order. Our larger cities now require the wires to be placed under ground, thus adding considerably to the problem as presented to the engineer; and the troubles experienced in severe winters are leading the companies to bury certain of their more important long-distance lines.

In addition to all of these worries, which would seem to be enough for any one class, the telephone engineer must keep his eye on the future, and see wherein his service may be improved or extended. It is a great feat to be able to meet the requirements of a large city, but to be able to forecast them and provide for unprecedented growth is still greater.

Some of the problems with which these two branches of engineering are to-day contending are referred to in the presidential address of Mr. John Gavey, on the occasion of his entering into office as president of the Institution of Electrical Engineers of Great Britain.

The telegraph engineer, in spite of the general impression that he is clinging tenaciously to the old, simple Morse system, because he thinks the public can be satisfied with the service thus secured and he does not want to incur the expense of introducing a new system, has been for years looking for a rapid printing telegraph. A number of such systems have been invented, but the majority of them do not seem to Mr. Gavey to meet the needs of the telegraph companies. He thinks, however, that we are well under way toward the solution of this old and difficult problem. In the new branch of the telegraphic art—wireless telegraphy—although a great many types of receiving instruments have been produced, and it has been found that there are many ways of constructing devices which would be sensitive to electric waves, the state of the art is, in his opinion, still unsatisfactory.

In telephony there are still a number of pressing problems awaiting our final solution. A really satisfactory relay or repeater is badly needed. While an expert telephonist can maintain a satisfactory conversation over a long-distance line of, say, 1,000 miles or more, the average user can not do so, as his ear is not sufficiently trained. A satisfactory relay would much improve the condition. Placing the wires under ground also increases the difficulty of successful long-distance communication, and much work has yet to be done in applying the loading principle to such lines so as to eliminate the deleterious action of the buried wire.

Evidently there is yet much to be done in these two important branches of engineering. These problems are difficult, and in order that that may be attacked successfully, it is necessary that the highest amount of technical skill, combined with practice and familiarity with the conditions of operation of the several systems, be available. These two arts differ principally from those of power transmission, electric railroading and other industries in that the amount of power to be transmitted is small—in the case of the telephone, exceedingly small, but this only adds to the difficulties of the problem.

THE GAS TURBINE PROBLEM.

The enthusiasm with which the steam turbine has been received of late, in spite of the disheartening struggles which Parsons had in the early days of its development, has turned the attention of engineers and others toward an extension of principle of the new motor to a gas engine. The thermodynamic efficiency of the gas engine is much better than that of the steam engine, and the mechanical advantages of the steam turbine as compared with the reciprocating type of engine appeal so strongly to engineers that it was thought an ideal combination would be to apply as nearly as might be the thermodynamic cycle of the gas engine to a machine making use of the principles of the steam turbine.

The idea is not an entirely new one, but has not been discussed critically until recently. During the past year, however, there have been a number of papers presented on this subject. On the whole, they have been discouraging to the advocates of this type of engine, pointing out serious mechanical obstacles to the construction of a satisfactory gas turbine. The latest of these papers to be read was that presented recently by Mr. Dugald Clerk before an engineering association of England.

Mr. Clerk took a very discouraging view of the possibility of a successful gas turbine. Some of the difficulties mentioned are large, but some of them do not seem to be as important as his paper would indicate. The greatest admittedly lies in the effect of high temperatures upon the turbine parts. This, it is said, will make it necessary to modify the cycle of operation as compared with that of the gas engine. In the latter, temperatures as high as 1,500, or possibly 2,000 degrees centigrade may be attained. In the turbine it is said that the maximum temperature must not be over 750 degrees centigrade. Should this be found true, the turbine would lose greatly in efficiency as compared with the reciprocating engine.

Another objection is the inefficiency of the auxiliary apparatus. It will be necessary to compress air, and the inefficiency of our present types of compressors will affect directly the performance of the turbine. Still a third objection made by Mr. Clerk was the great loss of heat which he assumed to take place, due to conduction, particularly from the expanding nozzles. This objection would not seem to be serious, since the time required for the gas to pass through the nozzles is so short that the amount of heat it could lose would be trifling.

Mr. Clerk said that while he did not think there was much hope for a great improvement in prime movers by the production of a gas turbine, he was still in favor of having the device studied experimentally, but he warned his audience, which was composed largely of young men, not to waste their time upon it. He thought the turbine might possibly be applied to advantage in utilizing the exhaust of the internal-combustion engine, much as Rateau has done with the steam turbine.

When one recalls the objections with which Parsons was met when he first took up the steam turbine, and the ridicule which he had to bear, and then remembers the eagerness with which mechanical engineers are to-day adopting this engine, one feels that it will be just as well to suspend opinion upon the gas turbine until more experimental work has been done. We are not limited to the conditions considered by Mr. Clerk. He has said nothing about the possibilities of a cycle in which the temperature of the gases is lowered by the addition of steam. The principle of the turbine is so simple, and it is so well adapted to driving electrical machinery, that it could afford to be less efficient thermodynamically than the reciprocating gas engine, and still be a more efficient machine commercially. The machine is worth investigation anyhow, for even if it should be shown that it is not commercially advantageous, the work would still be valuable in clearing up the physics of the subject, about which at the present time we are somewhat in doubt.

THE TELEPHONE POLE.

Nothing will cause one to realize more clearly the great extension of the use of the telephone than a drive or a walk through the country. Everywhere one goes he finds the road bordered with a line of telephone poles. In the towns these lines are more substantial, and carry more wires, but in localities further removed from settlements, he still will find a line carrying possibly not more than one or two wires, looping in at a house here or a store there, thus connecting together and to some neighboring village a fair proportion of the houses of the district. While the city service is, of course, much greater, both in its equipment and in the use to which it is put, the rural service may be compared with it in its importance to those who employ it. It gives a sense of security not only to the subscriber, but to the neighbors, who know that in case of necessity there is means at hand for quickly obtaining assistance. These rural systems meet a long-felt need. There is nothing that can take their place. They give a means of communicating quickly; they save much time and trouble in running errands and delivering messages; but, more than all, they remove that feeling of isolation which is so often a drawback of the country house, without in any way reducing the owner's privacy. It brings one's neighbors within call, without bringing them into sight, and this is obtained at a moderate expense, a consideration not to be overlooked. The rural telephone system, judging from its advantages, seems likely to grow into enormous proportions before many years are passed.

THE REPORT OF THE COMMISSION ON ELECTRIC LIGHTING FOR THE CITY OF NEW YORK.

Elsewhere in this issue there appears a brief abstract of the report of the commissioners on electric lighting for the city of New York, dealing with the question of a municipal plant for the borough of Brooklyn and the borough of Queens. As was to be expected, the commission reports that, including the duct system, the over-all charges would be considerably in excess of that regulated by recent legislation. The figures given, showing the relation of operating costs to total charges, are particularly interesting at this time, when the agitation for municipal ownership is very apt to be misguided and ill-advised.

THE ELECTRICAL NATURE OF MATTER AND RADIOACTIVITY.

BY HARRY C. JONES.

CHAPTER XI.

The Production of Heat Energy by Radium Salts.

An observation of the greatest importance was made in 1903 by M. Curie and Laborde. *Salts of radium have a temperature that is continually above that of the surrounding medium.* This means that heat energy is being produced in the radium compound. That the radium salt is warmer than the surrounding air can be shown qualitatively by means of the fairly sensitive mercury thermometers. It can be readily demonstrated in the following manner, according to Mme. Curie. A double-walled glass bulb was made, and the space between the two walls exhausted. The object of removing the air is to render this space between the walls a very poor conductor of heat. Into such a vacuum-jacketed vessel the bromide of radium, placed in a glass tube, is introduced, together with a fairly sensitive thermometer. Into a second such vessel a similar thermometer is introduced. The thermometer near the radium salt, which weighed only 0.7 gramme, registered two or three degrees higher than the thermometer in the vessel which contained no radium. Thus, quite appreciable differences in temperature can be produced with the few decigrammes of the radium compound that were at disposal. With larger quantities of the salt still greater differences in temperature would result.

MEASUREMENT OF THE HEAT LIBERATED BY SALTS OF RADIUM.

Several methods have been employed to measure the *quantity of heat* liberated in a given time, by a given quantity of radium. A rough method carried out by M. Curie and Dewar is more novel and interesting than important. It is well known that Dewar, provided with the splendid low-temperature plant of the Royal Institution, has been able to obtain in large quantities all of the lowest condensing gases with the exception of helium in the liquid form.

He has obtained liquid hydrogen in considerable quantity, and worked out a number of its interesting properties. He has determined its boiling-point, and found this to be only about twenty on the absolutive scale, which is —253 degrees centigrade. If heat is added to liquid hydrogen it will boil. On account of the very low temperature at which liquid hydrogen boils, it will take up heat from any surrounding liquid except more of the liquid hydrogen itself, and would thus continue to boil without cessation, or at least to give off appreciable quantities of hydrogen gas.

A test tube whose lower half was surrounded by a double-wall vacuum jacket, was filled about one-third full with liquid hydrogen. This was then immersed in a larger vessel, also surrounded by a double-walled, vacuum jacket, and the space between the two filled with liquid hydrogen. The hydrogen in the inner tube soon ceased to give off any appreciable amount of gas, since it could not obtain the heat necessary to convert itself into vapor—the conduction of heat being prevented by the hydrogen in the outer vessel, which always continued to give off gas. If any heat is now supplied to the liquid hydrogen in the inner vessel, a part of the liquid would be converted into vapor which would escape.

The experiment consisted in arranging the system as above described, and waiting until the gas ceased to escape from the inner vessel. A weighed quantity of the radium salt, sealed up in a glass tube, was then introduced into the liquid hydrogen in the inner tube. The tube and salt being at ordinary temperatures when introduced into the liquid hydrogen, would give up heat to the liquid until they were cooled down to the temperature of the liquid hydrogen itself. This would, of course, volatilize a part of the liquid, and gaseous hydrogen would escape. After the small glass tube containing the radium salt and its contents, had been cooled to the temperature of the liquid hydrogen, gas would cease to escape from this tube, unless the radium gave off heat. In fact, gas continued to escape from the tube, as long as any liquid hydrogen remained in this vessel. This was due to the heat being given off continuously by the radium.

It is obvious that the amount of hydrogen gas set free in a given time can be used to measure the rate at which heat is being liberated by the radium. It is only necessary to collect the hydrogen and measure it by any of the methods for measuring a gas, and to determine the heat of vaporization of hydrogen, *i. e.*, the amount of heat required to produce, say 100 cubic centimetres of hydrogen gas, from the liquid. Weighing the amount of pure radium salt that was introduced into the liquid hydrogen, we have all the data necessary for calculating the rate at which radium liberates heat energy, or the amount of heat produced by a given quantity of radium in a given time. While this method is far less accurate than the one to be described subsequently, it is useful as a confirmatory check; and interesting when we think that the liquid which is vaporized by the heat spontaneously produced by radium is one that was unknown until the last few years, and one which defied the skill of so many able experimenters to produce, including the immortal Faraday.

This method of measuring the amount of heat liberated by radium, has one feature which is of special importance. The radium is giving off heat, under these conditions, at the temperature of liquid hydrogen, which is only about twenty degrees centigrade about the absolute zero. By comparing the results of this method with those of methods that can be employed at ordinary temperatures, we can see what effect temperature has on the rate of heat production by radium.

If the production of heat in salts of radium is due to any chemical action, we should expect that the rate at which heat is evolved by radium would be greatly lessened at the very low temperature, since nearly all chemical reactions take place more slowly the lower the temperature. Indeed, most chemical reactions fail to take place at all at the temperature of liquid hydrogen.

It has been found that *radium liberates just as much heat at the temperature of liquid hydrogen, as at ordinary temperatures.* This alone makes it highly improbable that the heat liberated by radium in its salts is due to any chemical action taking place within the compound. We shall see later that the *amount of heat* liberated by salts of radium, is of an order of magnitude so much greater than that known in the case of any chemical reaction, that this source of the heat energy is almost certainly excluded. Further, the fact that salts of radium continue to produce heat for apparently an almost indefinite time, excludes the possibility that it is produced as the result of chemical action.

METHOD OF THE BUNSEN ICE CALORIMETER.

The amount of heat liberated by salts of radium is measured most accurately by means of the *Bunsen ice calorimeter.* The principle of this instrument is so well known that only a few words of explanation are necessary. The essential feature of this method is a block of ice, which is melted by the heat that it is desired to measure. Knowing the amount of ice converted into water and the heat

of fusion of ice, we have all the data necessary for determining the amount of heat set free in the ice calorimeter.

In some of the earlier work with the Bunsen ice calorimeter, the amount of water produced was obtained by collecting it and then weighing it. A more accurate method of determining the amount of ice that has been melted, is based upon the fact that the ice and the resulting water occupy different volumes. When water freezes the volume increases, and, conversely, when ice melts the volume occupied by the resulting water is less than that occupied by the ice. This principle is utilized in the following manner:

A V-shaped vessel is made, having one arm much larger than the other. The larger arm is double jacketed and the space between the walls filled with water, which is partially converted into ice. The smaller arm is filled with mercury, which also extends out into a graduated capillary tube. The whole apparatus is surrounded by ice to prevent absorption of heat from surrounding objects. When the end of the mercury column has reached a steady state and come to rest in the graduated tube, a weighed quantity of the radium salt, sealed up in a small glass tube and cooled in ice to the temperature of the calorimeter, is introduced into the inner tube of the calorimeter. The ice at once begins to melt, due to the heat liberated by the radium, and the volume of the water formed occupies less volume than the ice from which it was formed. This is shown by the end of the mercury column in the fine tube retracting. Knowing the coefficient of contraction of ice on melting, *i. e.*, the difference in volume between a given mass of ice and the equal mass of water, and the volume of the fine tube in which the mercury column is moving, and the rate at which it moves when a known quantity of the radium salt is introduced into the calorimeter, we have all the data necessary for calculating the rate at which radium gives out heat energy.

RESULTS OF HEAT MEASUREMENTS.

The results are certainly surprising on account of their enormous magnitude. *A gramme of radium gives out every hour about eighty calories of heat.* Since the heat of fusion of ice is eighty calories, or eighty calories of heat are required to melt one gramme of ice, it follows that *radium gives out enough heat to melt its own weight of ice every hour.*

The most remarkable feature of all is the fact that radium continues to give out heat at this rate for apparently an indefinite time. We shall see later that this would go on as long as the radium itself continues to exist.

This is a most surprising result. Indeed, it is one of the most startling facts that has ever been discovered in any branch of physical science. Think of the enormous amount of energy that this substance is capable of liberating.

SOURCE OF THE HEAT ENERGY.

The question naturally arose whence came this energy? Some rushed to the conclusion that it must be created by the radium, and that the law of the conservation of energy was overthrown. Those who were less flighty concluded that radium must have the power to transform some unknown kind of energy into heat, which was essentially the same as to admit that they did not know, and had no tangible conception of the origin of this energy.

The more conservative began to look around for a rational explanation of this astonishing and most important fact, in the light of what was known, or what could be discovered.

We shall see a little later that their efforts were rewarded, and that we have a rational explanation as to the origin of the enormous amount of energy given out by radium.

It was pointed out by M. Curie that freshly prepared solid salts of radium give out relatively a small amount of heat, and that the amount of heat evolved increases, not reaching a limit even at the end of a month. Similarly, a solution of a radium salt in a closed tube gives out at first relatively little heat. The amount of heat evolved increases gradually, reaching a constant after about a month.

The activity of radium compounds also increases for about a month after they are newly prepared. Thus, the production of heat seems to be directly dependent upon the radiating power, or *vice versa.* We shall also take this matter up again a little later.

We have seen, then, that enormous quantities of energy are liberated by the element radium, and that this continues unabated for practically an unlimited time.

The heat energy is given off slowly, compared with the heat that is given out in certain combustions. This is the reason that the radium salt does not heat itself to a higher temperature above the surrounding medium. Another explanation of why larger differences in temperature do not exist, is that such small quantities of radium salts have thus far been obtained that the heat is lost by conduction through the relatively large surface exposed to surrounding objects. If large amounts of radium could be obtained it is quite certain from the rate at which heat would be produced, that the interior of a pile of radium chloride or bromide would become quite hot; and by suitably surrounding the salt with a medium that was a poor conductor of heat, it is quite possible that the interior of a pile of radium salt might become red-hot and actually give off light, due to the heat spontaneously produced by itself.

EFFECT ON SOLAR HEAT.

The fact that radium gives out heat energy has been utilized to explain certain natural phenomena, for which a satisfactory explanation has long been wanting. Take the heat of the sun, how is it produced? A number of theories have been advanced. The possibility of the heat of the sun being the result of combustion or any chemical action, has long since been abandoned. A similar fate has befallen the theory that solar heat is produced by meteoric bodies raining down from space on to the sun. Both of these views have been found to be insufficient in the light of well-known facts.

The theory that is held to-day is that the origin of solar heat is to be found in the *contraction* that is going on in the sun itself. This contraction would produce a constant shrinking, and a falling in of the exterior, which would give rise to heat; and in the case of a body of the dimensions of the sun, would give rise to enormous amounts of heat.

This theory is to be sharply distinguished from the older one, that the sun is simply a cooling body, giving out solar heat as it cools. According to the present theory enormous amounts of heat are being *continually produced* in the sun, while according to the cooling theory the sun is simply giving out heat like any other hot body.

This theory of the origin of solar heat has been found to be adequate. A contraction which would be too small to be observed during the time that careful solar measurements have been made, would account for all the heat given out by the sun during this period.

While this theory is capable of accounting for solar heat, there has, however, been a reservation in the minds of men of science, which has made them hesitate to accept this theory as the final explanation of the origin of all solar heat.

The discovery of the large amount of heat liberated by radium, has been utilized

by some to account for at least a part of the solar heat. If the sun consists of a very small fraction of one per cent of radium, this would account for the heat that is given out by it. As Strutt points out, if the sun contained only a little larger per cent of radium than the pitchblende from Johanngeorgenstadt, or from Joachimthal, that the heat that would be emitted by this radium alone would be equal to *all* the heat given out by the sun.

The fundamental question in connection with this theory as to the origin of all or part of the solar heat, is this, does the sun contain radium? Is there any evidence, direct or indirect, that radium exists in the sun.

It must be said that no direct evidence has as yet been produced to show the presence of radium in the sun. The supposed discovery of the spectrum lines of radium in the sun, leaves much to be desired. The supposed coincidences of the solar lines with the known lines of radium are only rough approximations. Indeed, so rough that it is far from being convincing.

DOES RADIUM EXIST IN THE SUN?

Indirect evidence of the presence of radium in the sun is, however, forthcoming. It has been shown by spectrum analysis that helium exists in the sun. Indeed, this element was first discovered in the sun, as its name implies. It was only recently discovered by Ramsay as occurring at all on the earth. We shall see that helium and radium are most closely associated. Wherever we find the one, we may reasonably expect the other. Helium, having been shown to exist in considerable quantities in the sun, the conclusion is highly probable that the sun also contains radium. The force of this argument will appear, and be the better appreciated, when the exact relation of helium and radium is taken up in a later chapter. The hypothesis of the radium origin of even a part of the solar heat, is only an hypothesis, which it will remain for the future either to raise to the rank of a theory, or to disprove.

TERRESTRIAL HEAT PRODUCED BY RADIUM —BEARING ON THE CALCULATED AGE OF THE EARTH.

We have seen that radium exists widely scattered over the surface of the earth. While only small quantities have been found in any one place, and while, in the opinion of the writer, for reasons already expressed, this is likely to be the case, yet the total amount of radium in the earth may be very considerable. Indeed, there are reasons for supposing that beneath the surface of the earth there may be more radium than on the surface. The waters from certain springs, which probably come from considerable depths, contain radium. All of this radium is continually giving out heat.

Rutherford points out that the heat liberated by radium in the earth may have an appreciable effect on its age as usually calculated. In such calculations, starting with the earth as a molten mass, the main factors that are taken into account are: the specific heat of the earth to determine how much heat it contains, and the conductivity of the crust of the earth for heat, to determine the rate at which the earth is losing heat. Given these data, the problem is to determine how long it would require the earth to cool from the condition of a molten mass to its present state.

In this calculation it is not assumed that there is any large source of heat production going on within the earth itself. The hydration of the rocks, or the combination of the rocks with water as they cool would liberate some heat, and this is taken into account. If, however, it should be shown that there is an appreciable quantity of radium in the earth, this would give off heat continuously, and in geological time the amount of heat from this source might be very considerable, relative to the total heat in the earth itself. This factor might vitiate the calculation of the age of the earth on the basis of the data that have been used, and produce a very considerable error in the result. The magnitude of the error would, of course, depend entirely upon the amount of radium in the earth.

THEORIES AS TO THE SOURCE OF THE HEAT ENERGY PRODUCED BY RADIUM.

Several theories have been advanced to account for the production of the heat energy that is continuously being liberated by radium. One is strictly analogous to the contraction theory of solar heat. The radium atom is contracting or shrinking up, and heat is therefore produced. This theory, which never met with much favor, is now untenable, for reasons that will appear as the subject develops.

The theory as to the origin of heat in the salts of radium, which accounts satisfactorily for the facts, and which is now generally accepted, is the following. We have seen that the α particles shot out by radium are incapable of penetrating any appreciable thickness of matter. They are all absorbed by thin screens. We have also seen that these particles have a mass at least twice that of the hydrogen atom, and possibly greater, and are shot out at very high velocities. These particles would, therefore, have large amounts of kinetic energy, and when they are stopped this would be transformed into heat and would yield a large amount of it.

Take a pile of radium salt, the α particles shot off from the surface, not coming in contact with any of the salt above it, would escape at least a few centimetres into the air. But the α particles shot off from all of the radium at any appreciable distance beneath the surface of the salt, would not escape, but would strike the solid salt above it and be stopped. The energy of motion of the α particle would thus become converted into heat. Since the mass of the α particle is considerable, and the velocity about one-tenth that of light, the momentum would be great, and the amount of heat produced considerable.

This theory, which accounts for the heat liberated by radium, as produced by the stopping of the α particles in their flight, leaves still one question unanswered. How do the α particles acquire this great velocity with which they are shot off from the radium?

We can scarcely conceive of particles at rest in a molecule being shot off with such velocities. The particles in the molecule or atom of radium—the electrons—must be moving with very high velocities, and when a particle, in its motion, gets beyond the control of the attractions of the remaining particles of the system, it flies off. This is true of the positively charged α particles, and also of the negatively charged β particles. The kinetic energy of these particles is then something inherent in the atom of radium itself. This we call *intrinsic energy*, or something inherent in the atom itself. It is obvious that this is the real source of the heat liberated by radium. The astonishing feature is the amount of the intrinsic energy contained in the atoms of radium.

THREE REMARKABLE PROPERTIES OF RADIUM.

We have thus far met with at least three properties possessed by radium, which are in the highest degree remarkable.

(1) We have seen that radium has the *power to charge itself electrically.*

(2) It also has the power to illuminate itself, or is, as we say, *self-luminous.*

(3) We have just seen that radium produces heat energy spontaneously, or *can warm itself.*

These three properties alone would suffice to place radium in a class by itself.

The Murgas System of Wireless Telegraphy.

By Joseph Murgas.

THIS invention relates to means for transmitting intelligence through disturbances in the ether and dispensing with wires. The art to which the invention belongs is commonly designated as wireless telegraphy.

In patents Nos. 759,825 and 759,826, granted to me May 10, 1904, a method and means are set forth whereby messages may be transmitted with greater rapidity than previously obtainable. According to the system therein described, tones of different pitch are employed in place of the dot and dash of the well-known Morse system. This is accomplished by causing different spark-gap frequencies at the sending station corresponding to the different tones, and these frequencies are produced by a plurality of interrupters, any one of which may be included at will in the circuit of a source of direct current. This means of producing sparks of the desired frequencies has disadvantages; among which may be mentioned those which are well known to be attendant upon the rupture of an electric circuit, such as arcing at the interrupter terminals and consequent destruction of these terminals, especially where large amounts of energy are employed, as well as the disadvantages attendant upon moving parts.

It is the main object of the present invention to produce different spark frequencies from a source of current without the employment of interrupters.

Auxiliary and other objects of the invention will appear hereinafter.

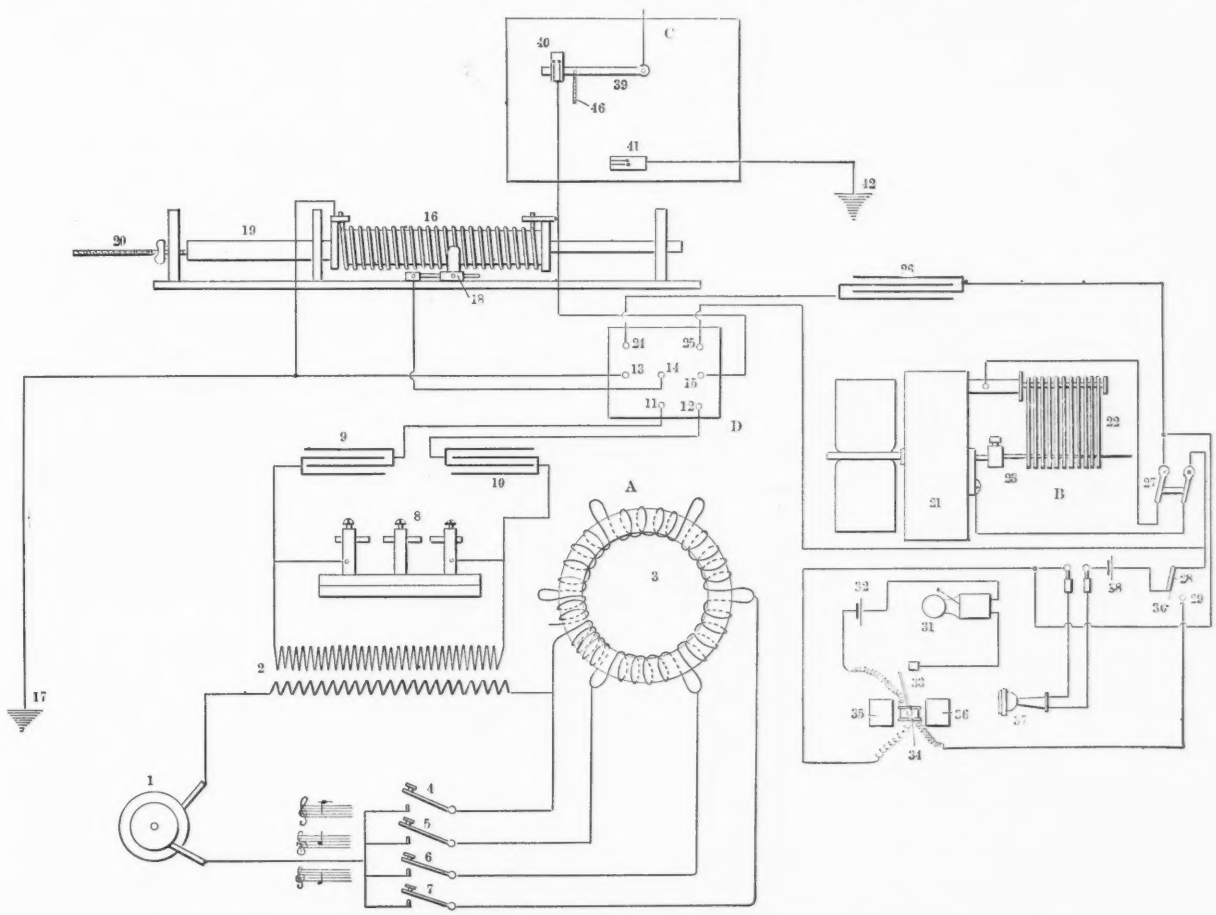


FIG. 1.—APPARATUS AND CONNECTIONS AT ONE STATION—MURGAS SYSTEM OF WIRELESS TELEGRAPHY.

In the accompanying drawings, which illustrate the invention,

Fig. 1 is a diagram showing the apparatus of one station and the connection thereof.

Fig. 2 is a detail of an improved imperfect contact, and

Fig. 3 is a diagram showing an improved arrangement of receiving apparatus.

The transmission of a message presupposes the existence of two stations, one sending and the other receiving, but as the apparatus at the two stations is identical, an illustration of the apparatus at one is sufficient for the purposes of description.

Referring to Fig. 1, a station comprises sending apparatus A, receiving apparatus B, the usual antennæ or aerial wire C, and switching means D, for connecting either the sending or the receiving apparatus to the antennæ at will.

The sending apparatus comprises a source 1 of alternating current, one terminal of which is connected to a terminal of the primary of the transformer 2. The other terminal of the primary is connected to one end of an inductance 3, and also to one terminal of a normally open switch or key 4, the other terminal of the switch being connected to the other terminal of the alternating-current source. Other keys, 5, 6 and 7, similar to the key 4, are also connected to the last-mentioned terminal of the source 1, and to taps taken from different points of the inductance 3, so that by closing the

proper key the source may be connected directly to the terminals of the transformer primary, or any one of several portions of the inductance may be connected in circuit therewith.

A spark-gap 8 is connected across the secondary of the transformer. The gap, as a whole, may consist of a plurality of breaks as shown or may consist of but a single break. The terminals of the gap are preferably made adjustable, as shown. The terminals of the gap are respectively connected through the condensers 9 and 10, with the contacts 11 and 12 of the switch D. The switch D may be of the well-known three-pole double-throw type. The middle contacts 13, 14 and 15 of the switch are, in the order named, connected one to one end of the inductance 16, and to the earth at 17, another to the sliding contact 18, adapted to contact with the coils of the inductance 16, and the other to the other end of the inductance 16 and to the antennæ C. It will now be seen

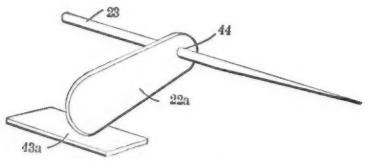


FIG. 2.—THE IMPERFECT CONTACT, MURGAS SYSTEM OF WIRELESS TELEGRAPHY.

that when the switch D is thrown downwardly, the transformer secondary and spark-gap connected in parallel are connected through condensers in shunt with an inductance interposed between the antennæ and ground. The amount of the inductance included between the terminals of the secondary circuit may be regulated by sliding the contact 18 in one direction or the other as may be required to include a greater or less number of turns. To effect a further and nicer adjustment of the inductance, means may be provided for varying the distances between its turns. This may be accomplished by means of a plunger 19, bearing against the end of the inductance coil and moved in one direction or the other by a suitably mounted screw 20. When the screw is turned in one direction the coil will be compressed, while when the screw is turned in the other direction the coil will be lengthened.

The apparatus of the secondary circuit described, containing the secondary of the transformer, the spark-gap, the condensers and the inductance, constitutes an oscillatory circuit well known in the art, and which may be adjusted in a well-known manner to produce the desired results.

When messages are to be sent by means of tones, as set forth in the patents before referred to, the alternator is adjusted to run at a suitable frequency, which may be fixed. The spark frequency depends upon the length of the gap, being less when the spark-gap is greater, and vice versa, and the gap is adjusted so that when the key 4 is closed (the alternator connected direct across the transformer primary) a spark frequency corresponding to the frequency of the alternator and a tone is produced. It will be understood that the inductance capacity and resistance of the oscillator will be adjusted in a well-known manner to produce the desired oscillatory effects. To secure another tone, the spark frequency may be lowered by inserting inductance in the primary circuit. This may be accomplished by depressing the key 5, which is connected to a point in the inductance 3 such that sufficient inductance will be included in the primary circuit to produce a spark frequency corresponding to a lower tone. This tone will differ by an octave or octaves from the first, and the point at which the key is to be connected,

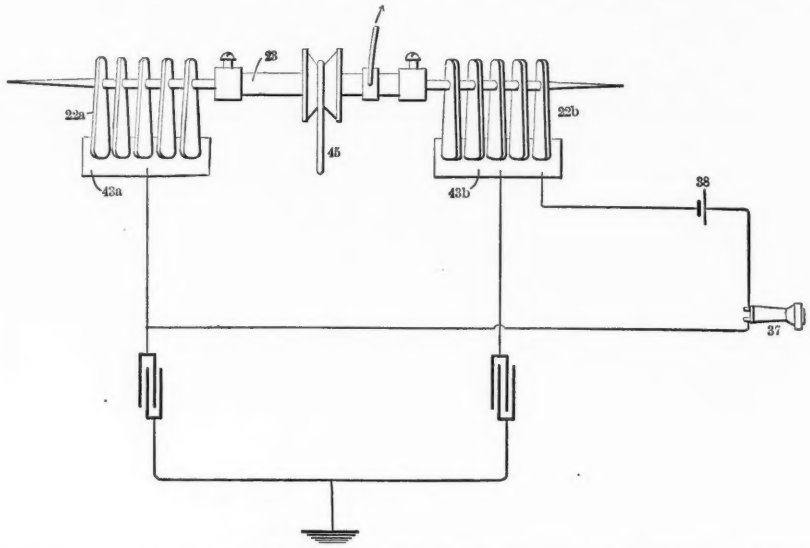
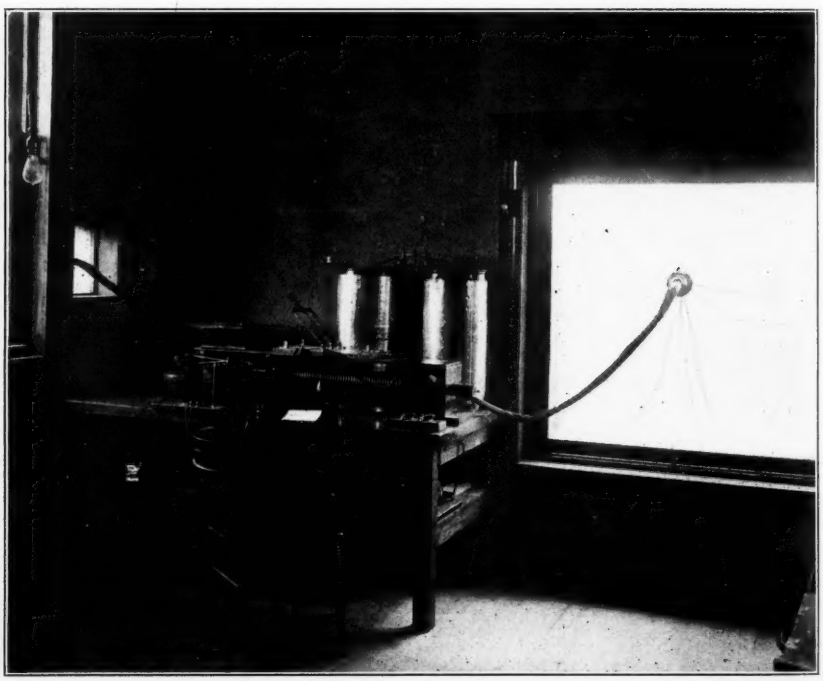


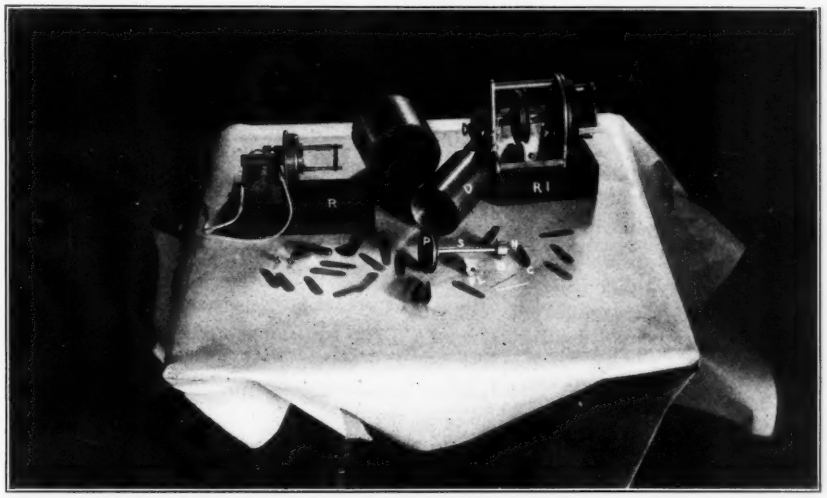
FIG 3.—ARRANGEMENT OF RECEIVING APPARATUS, MURGAS SYSTEM OF WIRELESS TELEGRAPHY.



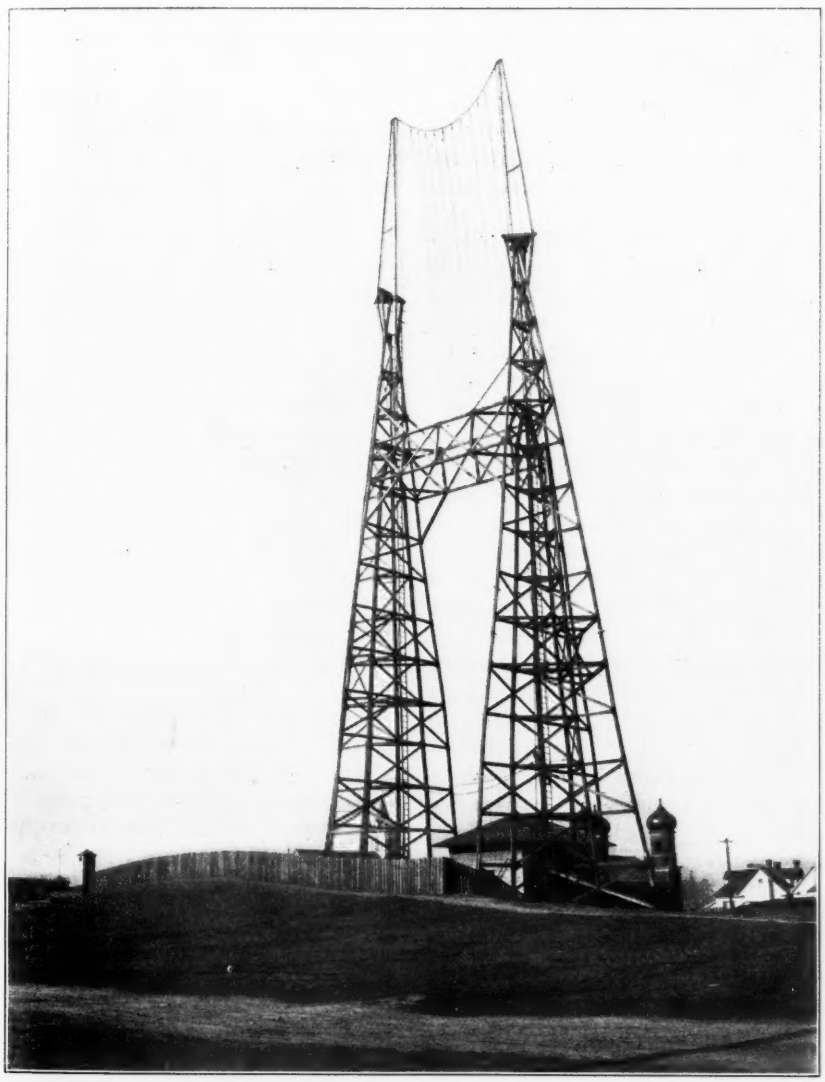
INTERIOR OF SENDING AND RECEIVING STATION, WILKESBARRE, PA., MURGAS WIRELESS TELEGRAPH SYSTEM.

to include the proper amount of inductance, may be ascertained by gradually inserting inductance until the tone is produced. The keys 4 and 5 and connected apparatus are sufficient for the purposes of sending a message, since two tones will fulfil that purpose, but if other tones are desired, additional keys, as 6 and 7, can be connected to other points of the inductance 3, corresponding respectively to other tones. The points at which the additional keys are to be connected may be ascertained as before described, and the several tones will differ from each other by an octave or octaves. It will now be obvious that a message is sent by depressing the keys in the proper order to produce tones as required by the code employed.

The receiving apparatus comprises an imperfect contact driven by the motor 21. As in my patent referred to, and the contact itself may be as therein described, but is here shown as a number of carbon bars 22, bearing at one end upon a polished steel shaft 23, driven by the motor, and at the other end upon a platinum support



DETAILS OF RECEIVER—R—WAVE DETECTOR, TAKEN TO PIECES. R_1—WAVE DETECTOR, SET UP. D—COVER. S—STEEL SHAFT. P—PULLEY. B—NUT FOR CLAMPING NEEDLE. N—NEEDLE. C—CARBON. PL—SUPPORT, COATED WITH PLATINUM.



EXTERIOR VIEW OF MURGAS WIRELESS TELEGRAPH STATION AT WILKESBARRE, PA.

43. As shown in Fig. 2, each of the carbon bars 22 is provided with a hole 44 at one end, through which the shaft 23 passes, while the other end of each bar rests freely upon the platinum support. While the apparatus shown in Fig. 1, a simple, imperfect contact, is employed, superior results are obtained by the employment of a plurality of them. The manner of employing a plurality of contacts is illustrated in Fig. 3. Referring to this figure, the shaft 23 is connected to a driving motor by any suitable means, as a belt 45. Bearing upon this shaft and upon platinum supports 43A and 43C, as before described, are two sets of carbon bars 22A and 22C. The antennæ are electrically connected to the shaft and each of the platinum supports is connected through a condenser to the ground. Message-receiving means, which may consist of a telephone-receiver 37 and a battery 38, are connected in series between the platinum supports. It will be observed that in this arrangement the imperfect contacts are connected in parallel between the antennæ and ground, and that they are connected in series across the message-receiving means.

The terminals of the contact are connected to the upper terminals 24 and 25 of the switch D, and when that switch is thrown upwardly these terminals are connected respectively to the antennæ and ground. A condenser 26 is inserted in one of the connections. A switch 27 may be provided for disconnecting the imperfect contact when sending, as strong discharges through the contact have been observed when oscillating waves are pro-

duced in the spark-gap. A switch 28, when bearing upon one contact 29, connects in calling apparatus, and when upon another contact 30, connects in receiving apparatus.

The call-receiving apparatus comprises a bell 31, connected in circuit with a battery 32, and a switch 33. The movable member of the switch is carried by a movable coil 34, mounted to turn in the field of magnets 35 and 36. When the switch 28 is upon the contact 29, the coil 34 is connected across the imperfect contact and upon receipt of an impulse at the station, the coil 34 is energized and moves in the magnetic field, thereby closing the circuit through the battery and bell 31, whereupon the bell rings.

The message-receiving apparatus comprises a telephone-receiver 37, and a battery 38. When the switch 28 is upon the contact 30, the receiver and battery are connected across the terminals of the imperfect contact and messages are received, as described in my patents referred to.

Preferably a switch 39 is provided which, when engaging contact 40, connects the antennæ to the sending or receiving apparatus, and when engaging contact 41 disconnects the antennæ from the apparatus and connects them directly with the ground as at 42. By this means contact 41 disconnects the antennæ from the station apparatus and connected with the ground in time of storm or at other times. A rope 46 may be connected with the switch 39, or other suitable means may be provided whereby the switch may be operated without rendering it necessary for the operator to place himself in dangerous proximity thereto.

It is to be understood that various constructions and arrangements of apparatus may embody the invention, and it should not, therefore, be limited to the structure and arrangement shown.

A Variable-Speed Steam Turbine.

A variable-speed steam turbine has been patented in England by Mr. W. J. A. London, and is described briefly in the *Mechanical Engineer* (London), November 11. The principle of operation consists in providing two sets of steam admission ports, into either of which steam may be directed at will. From one side of these ports the steam is conducted through expanding nozzles to the rotor, where it encounters two sets of movable blades and one set of fixed blades. It then passes to the exhaust port. This arrangement gives the higher speed. When steam is admitted through the other set of ports, it passes first through nozzles and then through the group of blades just mentioned, but in issuing from these is led through a channel to a second group of blades consisting of two fixed and two movable sets. This arrangement gives a speed about one-half that of the other. It is claimed that in this way two or more speeds may be obtained, all at approximately the same efficiency.

CONSTRUCTION OF CANADIAN NIAGARA POWER COMPANY'S 100,000-HORSE-POWER HYDROELECTRIC PLANT AT NIAGARA FALLS, ONTARIO.[1]

BY CECIL B. SMITH.

When the writer became resident engineer for this company in August, 1901, he found that the location of the works and discharging tunnel had been already decided upon, and a shaft for tunnel construction partly sunken, and under directions from Consulting Hydraulic Engineer Herschel, the turbine units were being given preliminary study by Escher, Wyss & Company, which also finally designed them. Aside from the tunnel, which evidently should be built at once of full capacity, the construction then authorized was for a canal of 50,000 horse-power, with temporary cribbing on the south side, a wheel pit for 50,000 horse-power and machinery and power-house for 30,000 horse-power, but the company in 1902 decided to build the canal for 100,000 horse-power, the wheel-pit for 110,000 horse-power (one 10,000-horse-power unit as a spare), to erect a power-house for 50,000 horse-power, and equip it with machinery to the same extent; and this plant, along with conduits for carrying underground cables to Niagara Falls, N. Y., and to a transformer station for 25,000 horse-power outside Queen Victoria NiagaraFalls Park, is now practically completed, and is in partial operation.

Some hazardous and approximate soundings had been taken in the Niagara river at the canal entrance, but they gave assurance that the depth of water adjacent to the shore was sufficient without extending operations very far out into the rapids, and a cofferdam was built. The cribs, if placed separately, would have been in rather unstable equilibrium, and the contractor accordingly sunk them in pairs, with turnbuckles in place, using temporary binding timbers to hold each two cribs in correct relative position until sunken into place, after which these timbers were removed by divers. The soundings for each crib were taken from a platform extending out over the water from the cribs previously placed, and the bottoms of the cribs were framed upside down, so as to fit the inequalities of bottom, denoted by the soundings. A floor for sustaining the rock filling was also placed in each crib as nearly as possible to the bottom, and the cribs were partly loaded before being floated into place. In order to hold on to the cribs when placing them in a current of ten feet to twelve feet per second, several lines of wire rope, operated by hoisting engines, were used, and only one mishap occurred, when the bottom of the large corner crib was torn off. It was found advisable to add vertical binding timbers, when cribs were to be placed in the heavy current. These are being found of advantage also during the removal of the cofferdam.

The puddle used was composed of about two-thirds gravel and one-third clay artificially mixed, as a natural mixture could not be obtained within a reasonable distance, and this mixture was found to fall quickly into place whenever leaks opened up, and could be rammed into a perfectly water-tight mass. It was found best, however, to keep the puddle-wall well below water-level on one side, so as to enable leaks to be promptly reached and the puddle to settle quickly. The continuous decking was built in place as soon as cribs were filled with rock, and being tied across by timbers above water and turnbuckles below, the cofferdam acted as one mass. In placing tongued and grooved sheeting it was broomed down by handmauls on to natural bottom, and fitted snugly around timber ties and turnbuckles, after which all openings at bottom, located by divers, were made tight by piling bags of rich cement mortar and ramming them into the apertures. When the cofferdam was pumped out by a battery of twelve-inch, ten-inch and eight-inch centrifugal pumps lifting about 10,000 gallons per minute, it was found that there was, even after temporary leakage through puddle had been cut down to nominal proportions, a heavy flow of water through the boulders and gravel lying between the cofferdam and solid rock, and as this would have to be handled for over two years it was considered advisable to take steps to stop it, and a puddle trench was sunk to rock at each end of area unwatered, being carried in each case from shore to adjacent points on inside of cofferdam. The cofferdam proper was sheeted on inside between these two puddle cut-off walls, with double-tongued and grooved sheeting extending from above water-level down to solid rock, layers of tar-paper being placed between the two layers of sheeting, and in order to seal the bottom a toe of rich concrete was carried along the bottom, being tied to the rock by thoroughly washing the surface of same, and spiking a heavy line of timber, about twelve inches above the bottom, to the sheeting. This interior sheeting held the pressure of water against it until torn off when letting water into the canal,

[1] Abstract of paper read before the Canadian Society of Civil Engineers.

and the whole leakage was cut down to about half of the capacity of one eight-inch pump during this period of over two years.

The original intention of the company was to build a steel bridge across the entrance canal, but it was subsequently decided to build a stone and concrete bridge fifty-five feet wide, composed of five spans of fifty feet each. Canal walls of rock-faced coursed ashlar, backed by 1 : 3 : 5 concrete, were carried out into the river by fifty-foot curves. The wheel-pit, which is 570 feet long and eighteen feet wide after lining, was excavated through fifteen feet of boulders and gravel, 100 feet of limestone, and fifty feet of shale, the sides being separated before blasting by channeling.

The original design for the tailrace tunnel was of a section twenty-one feet high, with brick lining sixteen and one-half inches thick, but this was finally modified to the present section, which is twenty-five feet high, and has a composite lining, the bottom and sides being of concrete, faced with four inches of highly burned brick, while in the arch a brick-ring with dry packing was adhered to on account of the difficulty which would have attended the building of a concrete arch. When the discharge tunnel was built for the Niagara Falls Power Company there was no exact information as to the value of the friction coefficient for a brick-lined channel of such large dimensions carrying water at a high speed, and even when the present tunnel was commenced the United States tunnel had not yet been tested to its full capacity, nor properly calibrated, but an examination in the winter of 1902 showed the brick lining, although of a very ordinary quality, to be absolutely intact, unworn and slimed over after seven years' use, with water flowing at about twenty-seven feet per second. Still, to make assurance doubly sure, the brick facing of the present tunnel was made of a superior burned smooth brick, and the section made about twenty per cent larger than the earlier one, so that the velocity will be slightly increased as the grade of seven feet per 1,000 is continuous, and the alignment of the tunnel very favorable, consisting of two curves of long radius with direct outlet in line with wheel-pit. This tunnel is 2,200 feet long, including the headworks at portal, which consists of a square head-wall sixty feet wide, twelve feet thick and fifty-five feet high, extending to a depth of thirty-five feet, below water-level, resting on a foundation well into the Medina sandstone; from this head-wall the tunnel rises in an ogee curve for some eighty feet to the tunnel proper, and this portion is lined with two feet of granite, which it was considered advisable to use in place of brick, owing to the excessive speed of the water when dropping to the river-level, it being understood that the invert of the tunnel at the top of the ogee curve is at the low-water river-level.

The excavation was carried both ways from a shaft sunk midway between the portal and wheel-pit, and was also carried in several hundred feet from the portal, and although the alignment was fixed from two piano wires twelve feet apart, suspended in the shaft, the instrument work at point of meeting of headings was found to be almost perfect, which must be looked on as a result of extreme care in the use of plumbobs, and taking the average of a large number of observations in this and surface instrument work. Owing to the upper portion of the tunnel being in shale, it was necessary to carry a full-timber roof consisting of five centered twelve-inch by twelve-inch rings, four feet apart and three-inch lagging, and these were put in place, along with the wall plates, as fast as the headings were driven, while the plumb-posts, carried down to limestone, were inserted at the time the two benches were being taken up. The original idea was to use yellow pine timber, but this was modified by substituting hemlock for centres and plumb-posts, where the stresses would be compressive, and, although they were much abused by blasting, the result was satisfactory, owing to the absence of much water to soften and swell up the shale roof; the portion of roof adjacent to the wheel-pit was subject to leakage when the pit excavation was being done just above the tunnel-level, and at this point the roof-timbers were badly crushed, and the centres settled several inches, the fibres of the hemlock segments being forced into one another.

The process of lining the tunnel was as follows: the concrete invert (1 : 3 : 5) being laid, the vitrified brick invert was placed as far as the corner specials; side-forms were then put up, and lagging, wedged back four and one-half inches, was placed as high as the first course of brick headers. After the concrete side walls were built up to this height, the lagging was removed, and the brick facing carried up to and including a header course, after which the process was repeated to the springing, the only variation being that dry packing was used between and behind the plumb-posts, in place of concrete shown on plans. The brick arch was built in the ordinary way on full centres, and four-inch by four-inch lagging, a night man building in the key of the arch-work done during the day, and laborers placing dry packing above the haunches and driving it home against the roof-timbers, also removing centres after being in position two or three days, and bringing them forward to a new position. After side-forms and arch-centres were removed, the whole tunnel was scraped clear of all mortar with sharp iron tools, leaving the surface smooth and clean. It is believed that a very low friction coefficient will exist in this tunnel, especially when the walls become slimed over with deposits from water, such as have formed on the walls of the Niagara Falls Power Company's tunnel. The shaft for this tunnel was sunk from May to September, 1901. Excavation was completed December, 1902, and lining and head-wall in May, 1904, after which the shaft was bricked up, and outlet excavation at portal completed during the summer of 1904. No attempt was made to hasten the completion of this portion of the plant before the machinery installation demanded it, otherwise much greater speed could have been made.

POWER-HOUSE.

The superstructure covering the generators and switchboard, etc., is a heavy steel-framed building, at present covering five 10,000-horse-power units, but the design is for a complete building 600 feet long, covering eleven 10,000-horse-power units, with main entrance at the north end. The main building is forty feet high to the eaves, and has crane-girders thirty-one feet above the floor, this height being necessary for proper movement of large loads from one part of the power-house to another, after the machinery was installed. The proper light effect is obtained by large arch windows below the crane-girders, and a series of smaller square ones just below the eaves. The exterior walls are of Queenstone gray limestone, with sufficient tooling for rich, quiet appearance, and the interior lining consists of a wainscoting of enameled brick up to the window-sills, then a belt course of green-veined Vermont marble in line with marble window-sills. Above this the lining will be buff brick which will give ample light in the daytime, while at night there is an arc light on each side of the power-house every twenty-four feet. The roof of the main power-house is of steel and terra-cotta tile only, the tiles being interlocking green Ludowici, pointed with mortar, and the eaves are carried well out with a slight upward curve, ending in heavy copper gutters.

The forebay room is attached to the east

side of the power-house, and has a flat steel and concrete promenade roof, with an asphalt and tile floor. It is surmounted by a stone parapet wall with twenty-four-foot panels, it being proposed to place electric light columns and flower vases at the panel-posts; while, for the purpose of throwing light into the room itself, in addition to arch windows every twenty-four feet, there is a wide continuous skylight in the roof adjacent to the power-house. In the forebay room a five-ton traveling crane spans the whole width, and will assist in keeping racks clean, and lifting them when necessary. All the main window-frames are metal, which leaves only the window-sash and small upper window frames of wood, so that, practically speaking, the building is strictly fireproof. At the north end the main entrance door will be of bronze with carved side columns, and surmounted by a panel containing the company's seal; while stretching across the north end of the power-house will be a visitors' gallery, from which the best view of the interior of the building can be obtained.

UNDERGROUND CONDUITS.

In order to convey current from the power-house two lines of conduits were constructed, one of which, 2,200 feet long, leads to a transformer station located outside the public park, and the other, one and one-quarter miles long, extends from the power-house through the park to the upper steel-arch bridge. The four-way ducts are embedded in a one to seven gravel concrete, and are spaced generously so as to provide proper heat radiation, it being found that in a large group of cables the centre ones do not have the carrying capacity of the outer ones. The manholes are also entirely of gravel concrete, and are drained thoroughly with six-inch tile, into which are carried the farm tile, laid alongside the ducts themselves; and a curtain-wall divides the manholes into two parts, while a further separation in case of fire is obtained by soapstone slab partitions lying horizontally between each group of cables. The ordinary type of manhole carries the cable straight through without any appreciable bends, and a twelve-inch water-main is used for carrying water from the pumps, located in the power-house, to the water-cooled transformers and stand-pipe situated outside the park on the company's land.

TRANSFORMER STATION.

On the tableland, immediately west of its works, the company has acquired a large tract of land, and on it has been built a transformer station of 25,000 horse-power capacity, eighty feet wide by 120 feet long, having a main central room thirty-eight feet wide equipped with a fifteen-ton Whiting electric traveling crane, copper oil tank, suction pump and motor, and cast-iron jack-rails, resting on concrete foundations. On these rails there have been installed, for the present, twelve transformers of 15,000 kilowatts total capacity, fully equipped with water-cooling drainage and lead-lined oil drainage systems. These transformers are for 40,000 or 60,000-volt transmission, and are separated from the low-tension and high-tension switchboards by solid brick curtain-walls, the cables being brought to the transformers through passages underneath the concrete floors and carried from them through overhead arches in the curtain-wall, thence to the high-tension switches, from which the wires will pass out of the building through specially designed windows. The building itself is of pressed brick, with stone sills and Ludowici tile roof, and is entirely fireproof, except window-frames. It has a central monitor roof for light and offices near the front entrance, which is a door of capacity for fully loaded freight cars to enter far enough to transfer loads to the crane. Adjacent to this station has been built a stand-pipe thirty feet in diameter by 116 feet high, which is connected to the main water system, from wheel-pit to transformer station, and the flow of water from which is controlled by a motor-driven valve operated from the transformer station, the object of which is that in case of fire the stand-pipe can be cut out, and the two pumps at the wheel-pit, by working tandem, can raise the pressure of water to 120 pounds at transformer station floor-line during the fire period. The function of this stand-pipe, however, is purely one of reserve in case of a breakage of the pumping and pipe systems supplying the transformers with water for cooling, in which event the stand-pipe capacity is estimated as being sufficient for 50,000 horse-power for twenty-four hours, or for forty-eight hours for the present station. In view of the importance of continuity of operation, this safeguard, although costly, was considered necessary; indeed, speaking of the equipment in general, every effort was made to design the plant so as to obtain a maximum of reserve in cases of breakdown.

POWER-HOUSE MACHINERY.

For handling materials two fifty-ton four-motor electric traveling cranes were installed, which, by working with a carrier, can together handle practically 100 tons. These cranes operate with 125-volt direct current, and have auxiliary five-ton hooks for fast service and light loads. The Sellers cranes, which are the ones here used, have, as a distinctive feature, fixed drums, the carriage only traveling. The speed requirements with full loads were: main hook, ten feet per minute; auxiliary hook, fifty feet per minute; trolley travel, twenty-five to fifty feet per minute, and bridge travel, 200 feet per minute. The main turbines have twin draught tubes emerging into the sides of the pit immediately above the invert, and, owing to the great depth of water which there will be normally in the pit with the whole plant in operation, not to speak of the effect of back water during high water in the lower river, it was necessary to locate the turbines about forty-seven feet above the invert of the tunnel, and although air pressure is equivalent to about thirty-three feet water-head, it has not been found practicable to operate safely with more than twenty-five feet of draught-tube effect, which necessitated some artificial means of creating pondage in the wheel-pit with only a few wheels in operation. The result was obtained by installing a huge regulating lift-gate at the extreme lower end of wheel-pit, where connection is made with the tunnel, and operating the same by lift-screws, overhead girder and eighty-five-horse-power 125-volt direct-current motor (a second motor in reserve). The water will pass under the gate, and in order to resist the constant vibration very heavy cast-iron grooves grounded and bolted into the brick lining walls of the wheel-pit rest against masonry especially cut and built into these walls to receive the grooves, and the gate is equipped with an oiling system fed from a flexible piping. The 10,000-horse-power turbines are described as twin inward discharge, Francis type, operating at 250 revolutions per minute, under 136 feet net effective head, and have solid bronze runners five feet diameter, and cylinder gates, controlled each by four racks and pinions. The racks move on opposite sides of the pinions, so that one gate rises as the mate to it lowers, the whole movement for each unit being controlled by a connecting rod from the Escher-Wyss governor situated on the power-house floor.

The revolving parts of a turbine and generator, and the shaft connecting them, are supported as follows: in addition to the upward thrust on the lower runner, there is a balancing piston located immediately above the wheel case, and the piston for each unit is directly supplied with

water from the forebay by a twelve-inch pipe, but as a reserve in case of an accident, there is also a connection with each penstock. In addition to this there is attached to each main shaft immediately beneath the generator a thrust bearing, capable, when operated with high-pressure oil, of carrying the whole weight of the revolving parts of a unit, which amounts to about 243,000 pounds. This bearing is fed from the oil chamber with oil, which is raised to a high pressure by a pump located immediately alongside on the thrust deck; after leaving the bearing the oil flows back to the chamber to be cooled, clarified and pumped back again to the thrust deck. The turbine shafts are hollow seamless cylinders forty inches in diameter, with weldless flanges, which connect by couplings to nickel-steel bearing-shafts fourteen inches in diameter, bored out eight inches at the various bearings and connections, there being two intermediate bearings for supporting the shaft between the thrust-bearing and balancing piston. The main penstocks each consists of a lower cast-steel elbow in two sections, weighing forty-nine tons, which sits astride of the pit and carries the weight of the penstock and the water contained therein; above this are five straight sections of riveted pipe ten feet two and one-half inches in diameter, having weldless steel flanges, and an expansion joint connecting to the cast-iron mouthpieces in wheel-pit wall by a steel upper elbow. The calculated speed of the water with full load on a unit is about eleven feet per second. Five units of 7,500 kilowatts output each makes the present installation, but the plant is built for eleven such machines, the eleventh being counted a spare, and in order to increase the present output it will only be necessary to extend the power-house building and install such machinery as may be required.

For supplying the various water-driven machines in the chambers, an independent water system has been installed, which consists of a thirty-six-inch riveted main with weldless flanges along the rack deck, fed from the canal by two thirty-six-inch and five twenty-four-inch vertical pipes. Of these, one thirty-six-inch and two twenty-four-inch pipes are in the first installation. From this main, which is subdivided by valves at various points, rising pipes enter the chambers, and after operating the machines, the water passes by draught-tubes into the tailrace below. In one chamber is located an exciter plant making 125-volt direct current, which is used not only for excitation of large generators, but for operating cranes, switches, various gate and pump motors, and lights, etc. This plant consists of three vertical direct-connected units of 332 horse-power each, the turbines being single, spiral case, inward and downward discharge, running at 600 revolutions per minute under 131 feet head, and controlled by Lombard governors. These units have oil bearings, supplied with low-pressure oil from the oil chamber, and are each quite independent, so that any unit can run with the other two shut down for repairs. In a second chamber are located two pump units. Each unit consists of a horizontal turbine direct-connected to a centrifugal pump of 3,000,000 gallons per twenty-four hours' capacity. These pumps can, as before remarked, be run in tandem in case of fire, so as to produce a fire pressure at the transformer station of 120 pounds with a pressure at the pump of 210 pounds per square inch. The turbines are driven from the thirty-six-inch auxiliary main and discharge into the tailrace by draught-tubes built into the brick wheel-pit lining, while the pumps draw their water from one of the twenty-four-inch supply pipes from the canal, and discharge by a twenty-four-inch pipe up the wheel-pit, and thence out and to the transformer station, a half-mile distant, by a twelve-inch water-main. In a third chamber there is a very complicated system of motor and Pelton driven Quimby screw oil-pumps, oil-tanks, filter tanks and cooling tanks, all so interconnected as to produce necessary circulation, which consists briefly, in there being two circuits, one for low-pressure and one for high-pressure oil. The oil traverses from a machine back to the cooling and filter tanks, thence to the suction tanks, from which it is again pumped back to the machine. The high-pressure oil is handled in the same manner, except that a special pump is located at each thrust-bearing, and raises the oil pressure at these bearings, after which this oil also flows back to the oil chamber to be cooled and clarified. In this chamber is also a specially designed Pelton-driven air-compressor, and in a chamber on the upper level adjacent to the main subway are located storage tanks of large capacity for storing oil, while a pressure oil-tank is also located in the roof of the power-house.

The main power-house floor will contain only three items of equipment—namely, the 7,500-kilowatt generators, the turbine governors and the main switchboard. So that the view from the visitors' gallery will be one of extreme simplicity, as the armatures of the generators are external and stationary, and the governors are very innocent-looking machines in line with the generators, and not observable from the north end of the power-house. The generators are about eighteen feet in diameter, with internal revolving fields, and deliver three-phase twenty-five-cycle current at 12,000 volts, which was adopted in order to enable local distribution for several miles to be made without transforming. As these generators were both too large and too heavy for transportation, it was necessary to have them completely assembled at the shops, then taken apart and packed in hundreds of boxes and shipped knocked down to the works, where it took several months to rebuild the fields and armatures piece by piece, there being, it is understood, 47,000 punchings in each armature. There are two subways just below the power-house floor, one to the right being for cables, and the main one to the left for cables and for the substructure of the main switchboard, which for each 50,000 horse-power is about 150 feet long. The subway itself runs the full 600 feet length of the plant, and has a series of chambers opening off to the left, one at each inlet breast wall, which will be devoted to miscellaneous purposes, such as location for small transformers, etc. The main switchboard consists of a lower part in the subway, made up of bus-bar compartments, divided up vertically by brick walls and horizontally by soapstone slabs, and containing motor-operated oil switches, and above the power-house floor the switchboard proper, from the gallery of which a full view of the power-house is had, and which is equipped with switches necessary for full control of the station. Cables leave the power-house by three manholes—one situated at each end and one at the west side—from whence they pass through conduits, already described, either to the transformer station or to Niagara Falls, N. Y., to deliver current supplementary to that generated by the Niagara Falls Power Company. These cables are lead-covered, two and one-half inches diameter, and contain three-phase nineteen-strand copper conductors, each one-half inch diameter, which are insulated by paper and gum wrappings, the whole three being again insulated by similar wrappings beneath the lead covering.

The ground for this plant was broken in September, 1901, although the tunnel and cofferdam had been nominally commenced somewhat earlier, and water was turned into the forebay November 9, 1904, the exciter chamber was ready for operation November 24, 1904, and the first

10,000-horse-power unit December 23, 1904—while two 10,000-horse-power units were ready for operation January 1, 1905. The third unit will be put in operation in a few months, and the fourth and fifth units during the summer of 1905, while the extension of wheel-pit complete, brick-lined and ready for the machinery of the remaining six units should be completed during 1905. It will be appreciated that during this period Queen Victoria park, with two other large and one smaller plant under construction, was in a state of great chaos, and this is largely the case at the present time, but the companies are under obligations to place their respective areas in good condition as soon as construction is finished, and when this has been done the southern part of the park, which was always in a state of nature, will be vastly improved. The Canadian Niagara Power Company, in process of construction, filled in the foreshore of the river for about 100 feet in width from the Horse-shoe falls southward for over half a mile, and this will be also sodded and added to the park area.

The principal contractors connected with the works were: James Barry, coffer-dam; Dawson & Riley, wheel-pit and canal; Queenstone Quarry Company, arch bridge; A. C. Douglas, tunnel and portal; Wm. Grace Company, power-house; Brass Brothers, transformer station; Escher, Wyss & Company, turbine units Nos. 1, 2, 3; I. P. Morris Company, turbine units Nos. 4, 5; General Electric Company, generators and main switchboard; Jenckes Machine Company, exciter turbines; Westinghouse Electric and Manufacturing Company, exciter generators; Canadian General Electric Company, transformers; Canadian Foundry Company, various lift-gates, etc.; Hamilton Bridge Company, power-house steelwork; in addition to which a great many contracts were placed in Canada and the United States for various pipings, steel floors, smaller machinery, etc. The policy was at once established of having continuous and thorough inspection in keeping with the rigid specifications and high class of work demanded, and a large number of inspectors were employed, who were located at the various manufacturing centres and on the work itself. As these men were all the best that could be found for the various classes of work being done, it is believed that the results warrant the large attendant expenditure. For mill material the Pittsburg testing laboratory did the inspection.

For the complete study, design and execution of such an undertaking as has just been described, the engineering department was necessarily somewhat complex, there never having been any chief engineer, either nominal or actual, the organization being as follows: chief mechanical engineer, Dr. Colman Sellers; consulting hydraulic engineer until December 31, 1903, Clemens Herschel; consulting engineer until March 1, 1904, W. A. Brackenridge; resident engineer in charge of construction, Cecil B. Smith; electrical engineer, H. W. Buck. Speaking generally, the designing was done under the direction of Consulting Engineer Brackenridge and by the designing staff of the Niagara Falls Power Company, in charge of A. H. Van Cleve, until March, 1904, since which time the writer assumed Mr. Brackenridge's functions; but the liberal policy of the company was that all the main points of design were determined after full discussion by the various engineers mentioned.

In carrying on the work of construction the company allowed the writer full choice of whatever staff was considered necessary, and to employ also such inspectors in different branches as were needed. The chief assistants were as follows: principal assistant engineer, G. A. McCarthy; assistant mechanical engineer, C. C. Egbert; assistant electrical engineer, G. E. Brown; assistant engineer of wheel-pit and canal, William Macphail; assistant engineer of tunnel, L. Sherwood. To these gentlemen the writer wishes to here tender his extreme appreciation of those qualities which made it possible to carry on such an extensive work with satisfactory results, and in that harmonious spirit which prevailed from the commencement of the work until the time (December, 1904) when the writer completed his engagement with the company.

Annual Meeting of the Underwriters' National Electrical Association.

The annual meeting of the Underwriters' National Electrical Association will be held at the rooms of the New York Board of Fire Underwriters, 32 Nassau street, New York city, on Wednesday, December 6, 1905, at 10 A. M. W. C. L. Elgin, secretary of the National Electric Light Association, has issued a call for all members to be represented at this meeting, as matters of great importance will be discussed. According to the formal notice issued, the meeting "will be open to all interested in the matter of rules for the installation of electric wiring and apparatus, as contained in the National Electric Code."

201st Meeting of the American Institute of Electrical Engineers.

The 201st meeting of the American Institute of Electrical Engineers was held at 44 West Twenty-seventh street, New York city, Friday evening, November 24. The meeting was called to order by President S. S. Wheeler.

Two papers were presented—one entitled "The National Bureau of Standards," by Dr. E. B. Rosa, and the other "A Testing Laboratory in Practical Operation," by Dr. Clayton H. Sharp.

The first paper was read in part by Director Stratton, of the Bureau of Standards, who briefly sketched the conditions which led to the establishment of the bureau, and the work done in bringing it to its present condition. After Congress had authorized its establishment and appropriated the necessary funds, a most excellent site was secured in the northwest section of the District of Columbia. The amount of money appropriated for the buildings was only $325,000, but the architect's plans were so drawn as to allow additional buildings to be added as the necessities required and funds were available, so as to adapt the whole to the work of the bureau. At the present time two buildings have been erected: the physical laboratory, a building of three stories and a basement; and the mechanical laboratory and power-house, a building of two stories and a basement. A third building is now nearing completion, which will be devoted to low-temperature investigations. This building will house the liquid hydrogen apparatus exhibited by the British government at the Louisiana Purchase Exposition last year, and then purchased by the Federal government for the bureau. These buildings are of fireproof construction, very substantial, and well adapted to the requirements. A general plan has been adopted whereby all rooms are equally well suited to investigations in any branch of physics. They are all provided with means for regulating the temperature, the lighting and the amount of moisture in the air. The mechanical laboratory is fitted up for mechanical testing, and has a complete isolated electric light, heat and power plant, and a well-equipped instrument shop. Director Stratton showed the equipment of this building by means of lantern slides.

Dr. Rosa followed Director Stratton, and by means of lantern slides described the arrangement and equipment of the physical laboratory. He showed also views of certain special instruments which had been developed by the bureau for particular investigations. Some of these

investments have been made in order to do the work requested of the bureau by outside institutions. Dr. Rosa also described briefly the exposition laboratory which was fitted up and used at the Louisiana Purchase Exposition.

The second paper was read in abstract by Dr. Sharp. It gives the reasons for establishing the Electrical Testing Laboratories in New York city, and outlines the character of the work done there, which includes testing of all descriptions. The main work of the laboratories at the present time is that of rating incandescent lamps, but tests of a great many kinds have been made. The laboratories will also rent facilities for conducting investigations—providing rooms, power and such apparatus as may be needed. The work has increased steadily since the laboratories were first opened in 1902.

The character of these papers offered but little opportunity for discussion. Professor F. B. Crocker, however, spoke at some length on the importance of standardization. He told briefly what had been done toward standardizing electrical units and the adoption of primary standards. He referred also to the progress which had been made in this country in standardizing the ratings and dimensions of electrical apparatus. Something has also been done in this line by mechanical engineers as regards engines. Professor Crocker thought that the time is coming soon when international standardization of apparatus, of engineering practice and of insurance questions can be attempted successfully. He referred to the different significance which the term "standardization" carries, as had previously been pointed out by President Wheeler, and he said that he liked the expression "uniformity of practice" when referring to engineering work.

Professor Crocker was followed by Professor W. E. Goldsborough, who spoke of the excellent work which had been done by the Bureau of Standards; by Mr. C. O. Mailloux, in somewhat the same strain; by Professor George F. Sever, who spoke of the relation between the educational institutions and the Bureau of Standards, and of that existing between the Columbia University electrical laboratories and the Electrical Testing Laboratories. The latter will furnish any one with results; the former, if desired, will give opinions upon these results.

Dr. Charles A. Doremus and Mr. John W. Lieb, Jr., also spoke of the excellent work done by the two institutions which had been described.

In answer to a question, Director Stratton said that it was difficult to draw a hard-and-fast line regarding the work of the bureau. While not primarily intended for commercial testing, a certain amount of work of this character must be done.

Report of the Commission on Electric Lighting for the City of New York.

The report of the commission on electric lighting for the city of New York, concerning the proposition of a municipal electric lighting plant for the boroughs of Brooklyn and Queens, has been presented to the board of estimate and apportionment. The report really takes the form of two special reports, designated as "C" and "D," supplementing reports "A" and "B," dealing with a proposed municipal plant for the boroughs of Manhattan and the Bronx, submitted some time ago.

Report "C" gives the cost of construction and operation of an electric plant to supply by electricity all the streets and public places of the boroughs of Brooklyn and Queens that are now lighted by electricity, and to light all the public buildings by electricity that are now lighted either by electricity or by gas, or both. Including land, buildings and all equipment for a central station of a capacity of 7,500 arc lamps and 200,000 sixteen candlepower incandescent equivalents, the total cost will be $6,138,000. The total annual operating and fixed charges, including interest at 3.5 per cent, depreciation at six per cent and all operating expenses, will be $919,000.

Subdividing the total annual cost of supplying arc and incandescent lights, the annual cost per arc light will be $83.40, and the cost per kilowatt-hour for incandescent service will be 14.68 cents. Of the total 14.68 cents, only 2.7 cents is operating cost, the balance, 11.98 cents, being for interest and depreciation. Taking the exact number of building and street lamps connected on December 31, 1904, as a basis of comparison, the annual cost of the city lighting for the boroughs of Brooklyn and Queens from the proposed plant would be $27,000 in excess of the cost under the rates recently fixed by the state legislature.

Report "D" gives the cost of construction and operation of a city electric light plant to supply all the city lighting by electricity, to the entire exclusion of gas, for streets, parks, public buildings and other public places in the boroughs of Brooklyn and Queens. Including land, buildings and all equipment for a central station of a capacity of 15,000 kilowatts, and a distributing system designed to supply 15,000 arc lamps and 200,000 sixteen-candle-power incandescent equivalents, the total cost will be $9,485,000. The total annual operating and fixed charges, including interest at 3.5 per cent, depreciation at six per cent, and all operating expenses, would be $1,424,000. The entire cost of a duct system for the restricted area in Brooklyn, and the main feeder-runs to the central station, is included in this cost. Only a part of this is required now, but it seems proper to include the entire cost, amounting to $2,226,000 in this estimate.

The annual cost of the city lighting for the boroughs of Brooklyn and Queens from this proposed plant will be $68,000 in excess of the cost under the rates recently fixed by the state legislature.

The Madison Square Garden Electrical Show.

The preparations for the electrical show, which will be held in Madison Square Garden from December 12 to 23, are now nearing completion. Many of the manufacturers of electrical appliances which are of popular interest have secured space and are devoting considerable money to the display of their products to show to advantage the advances which have been made in this industry.

The purpose of this show is to exploit in practical form the latest mechanisms and appliances that are marking progress in the world of invention and discovery, and to this end there have been gathered not only the latest machinery that is of value to the industrial world in reducing costs of production by creating greater energy with less fuel, but the more popular electrical apparatus that is rapidly adding to the comforts of home life.

In the middle of the hall will be located the telephone exhibit. Here will be seen the new "theatrephone," by means of which visitors to the exhibition will be enabled to listen to the words and music of the various theatres over a wire connected direct to the stages during the actual time of the performances.

By courtesy of the street cleaning department and of the department of bridges of the city of New York, steel models thirty feet long will be shown of the Williamsburg bridge and of the incinerating plant connected with it, where the refuse of the city is burned. A sample bale of the refuse from the streets is also exhibited.

The key by which President Roosevelt will formally open the electrical show from the White House will be on exhibition upon its receipt at the Garden.

In the concert hall, adjoining the main exhibition floor, lectures will be held at three and four o'clock every afternoon, and at eight, nine and ten o'clock every evening by Earle L. Ovington. These lectures will be supplemented by practical demonstrations.

THE MULTIPLE OPERATION OF TRANSFORMERS.[1]

BY R. T. MACKEEN.

It is universally considered good engineering practice to operate transformer units, suitably selected, in parallel. Without this means of increasing the capacity of a generating plant or distributing system, the expansion of the electrical industry would meet with serious impediment. While the advantages of the multiple operation of transformers are very generally appreciated by operating engineers, yet the results of the indiscriminate grouping of transformers in this manner are not so fully realized. It is the purpose of this discussion to present to the reader the principles involved in the multiple operation of transformers and thus endeavor to provide means whereby indiscriminate grouping of transformers can be guarded against, and instead a selection and arrangement adopted to accomplish the best results; as will be shown later, the grouping together in multiple of transformers too frequently results in the overloading of some of the units. This in practice is not usually considered, the main object being to get upon the circuit sufficient kilowatt capacity to take care of the maximum demand of the system.

It is often an occasion of some surprise when one or more transformers, part of a system operated in parallel, burn out, without any apparent reason. The capacity of the group of transformers is ample for the maximum demand; it therefore can not be due to overload, it must be the result of defective workmanship in the transformers, and thus the manufacturer has to bear the brunt of the results of the lack of knowledge or judgment on the part of the operator.

It is obvious that the successful solution of the problem is obtained if we can determine and provide the conditions under which each transformer on the circuit will carry a part of the load proportional to its rated kilowatt capacity output.

Let Fig. 1 represent an arrangement of transformers operating in multiple, with interconnecting leads of negligible ohmic resistance and reactance, and supplying a common load. Also assume the transformers are designed for the same periodicity and primary and secondary voltages; it being obvious that the two latter conditions are absolutely essential for parallel operation.

Let the transformers have resistances r_1, r_2, r_3, r_4, reactances x_1, x_2, x_3, x_4, thus having impedances z_1, z_2, z_3, z_4, it being remembered that the impedance is the square root of the sums of the squares of the resistance and the reactance, and is analogous or equivalent to the ohmic resistance in direct-current diction.

The equivalent resistance and reactance of a transformer (i. e., the value representing both primary and secondary resistance and reactance in ohms) bear the same phase relation to each other as the base and perpendicular of a right-angled

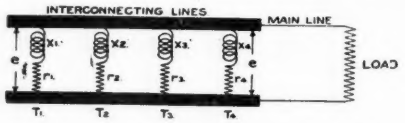


FIG. 1.—MULTIPLE OPERATION OF TRANSFORMERS.

triangle, the hypotenuse representing the impedance as in Fig. 2.

From this relation it is obvious that it is quite possible to have transformers with the same impedance yet widely different values of resistance and reactance. This suggests a point that should be considered, namely, the difference in phase between the impedance voltages and hence the currents of two transformers having identically the same impedance ohms and voltages (impedance volts being the product of impedance ohms and amperes). As seen, this is quite possible by varying the lengths of r and x, as shown in Fig. 3. This difference in phase doubtless affects the distribution of load to some extent, yet the phase difference in practice is so small as practically to be negligible in its results, and in fact it is quite safe to neglect this difference in phase

FIG. 2.—MULTIPLE OPERATION OF TRANSFORMERS.

and assume that all commercial transformers may have the same ratio of resistance to reactance, i. e., the same phase of impedance voltage and hence same power-factor, yet have widely differing impedances.

Our rules for load divisions are as follows:

First—"When two or more transformers of the same voltage and periodicity are operated in multiple and have interconnecting leads of negligible resistance, as in Fig. 1, the loads carried by each will be inversely proportional to their impedances, or directly proportional to their reciprocals, their admittances."

Second—"The load carried by each transformer will bear the same ratio to the total load as its admittance bears to the sum total admittances of all the transformers."

Just as impedance in alternating-current diction is analogous to resistance in direct-current diction, so admittance corresponds with conductance.

It is frequently thought that the distribution of load among transformers is proportional to their per cent regulations. This would be the case if the regulation were directly proportional to the impedance, but such is not the case.

It is more usual to express the impedance of a transformer in volts rather than in ohms. The impedance volts are easily determined by short-circuiting the secondary and applying a low potential to the primary until full-load current is obtained in the secondary. Manufacturers usually furnish this information on the test card accompanying their transformers. It varies in value from two per cent to five per cent of the primary voltage. As the impedance volts are directly proportional to the impedance ohms either value can be used in the rules given above, the only difference being that the impedance volts must be expressed in terms of unit-load for all the transformers. This follows from the fact that the impedance volts is the product of impedance ohms and amperes, and varies with the load. For example, a ten-kilowatt transformer has an impedance voltage of four per cent at rated full-load, or at unity load of $\frac{4}{10}$ or 0.4 per cent.

Now, since admittance is the reciprocal of impedance or $\frac{1}{z}$, the admittance for the above transformer is $\frac{1}{0.4}$ or 2.5, which we might call for simplicity the relative carrying power of the ten-kilowatt transformer as compared with any other transformers operated in multiple therewith.

Right here it should be noted that this value of admittance or relative carrying power can be obtained by simply dividing the kilowatt capacity of the transformer by its impedance voltage in per cent. For example: the carrying power of the above transformer is $\frac{10 \text{ kw.}}{4}$ or 2.5, the same result as before.

Now let us apply our rule to the de-

[1] *The Canadian Electrical News*, November, 1905.

termination of the division of load among five transformers of same voltage and periodicity connected in multiple, assuming as before that the impedance of the interconnecting line is negligible.

Size of Transformer.	Voltage.	Cycles	Per Cent Impedance. Volts.
5	1040/2080-104/208	60	4.0
10	"	60	3.8
15	"	60	3.5
20	"	60	2.8
25	"	60	3.1

As the division of load is proportional to the relative admittance or carrying power of each transformer, let us first determine these factors.

Size of Transformer.	Per Cent Impedance Volts.	Relative Admittance or Carrying Power = Kilowatt Capacity / Per Cent Impedance Volts.
5	4.0	1.25
10	3.8	2.63
15	3.5	4.29
20	2.8	7.15
25	3.1	8.06
75 Kw. Total		23.38 Total Admittance or relative carrying power.

Our rule states: "that the load carried by each transformer will bear the same ratio to the total load as its relative admittance or carrying power does to the total admittance or carrying power of all the transformers," hence the division of load will be determined as follows:

Size of Transformer.	Per Cent Impedance Volts at Rated Load.	Relative Admittance or Carrying Power.	Kilowatt Load Carried.		Per Cent of Total Load.	Per Cent of Rated Load.
5	4.0	1.25	$\frac{1.25 \times 75}{23.38}$	=	4.0 5.3	80
10	3.8	2.63	$\frac{2.63 \times 75}{23.38}$	=	8.45 11.20	84.5
15	3.6	4.29	$\frac{4.29 \times 75}{23.38}$	=	13.70 18.30	91.5
20	2.8	7.15	$\frac{7.15 \times 75}{23.38}$	=	22.95 30.60	114.8
$\frac{25}{75}$	3.1	$\frac{8.06}{23.38}$	$\frac{8.06 \times 75}{23.38}$	=	$\frac{25.90}{75.}$ $\frac{34.6}{100.0}$	103.5

From this computation we find that, theoretically, all the transformers will be carrying less than their rated load except the twenty-kilowatt and twenty-five-kilowatt sizes, which will be overloaded 14.8 per cent and 3.5 per cent respectively. This example serves to illustrate the method to be used in determining the approximate division of load for concrete cases.

It will be noted that the transformers with the higher admittances or relative carrying powers, and hence with the lesser impedances at unit-load, assume the greater part of the total load.

So far we have neglected entirely the impedances of the interconnecting lines between the individual transformers and the load. These impedances enter into the problem in practice to the extent that when known they must be added to the individual impedances of the transformers, and from this an expression representing the admittances or carrying powers determined. The difficulty is, however, to determine the line impedances; consequently, we can only approximate a division of load, assuming that the transformers are symmetrically disposed with regard to the load and each other, so that the line impedances can be neglected.

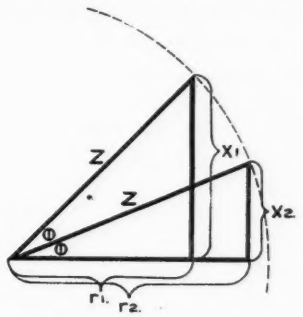


FIG. 3.—MULTIPLE OPERATION OF TRANSFORMERS.

Other factors also enter into the problem if we search for fine distinctions. For instance: the resistances and hence the impedances will vary with the temperatures of the transformers, which are not only functions of the design, but also dependent in great measure upon location and environment.

Before leaving our method of computation and discussing the generalities it is interesting to note that when transformers of different sizes but of the same voltage, periodicity and per cent impedance volts are operated in multiple, assuming negligible line impedance, the load will be divided among them in the ratio of the kilowatt capacity of each transformer to the total kilowatt capacity. For example: assume a ten-kilowatt transformer operating in multiple with two twenty-kilowatt transformers, all with the same per cent impedance volts at full-load. The ten-kilowatt transformer will carry $\frac{10}{20 + 20 + 10}$ or 1/5 of the total load, and each of the twenty-kilowatt transformers will carry 2/5 of the total load. This simple rule follows from the fact that the per cent impedance volts varies with the load, and at unit load the admittance or relative carrying powers would bear the same ratio to each other as the kilowatt capacities of the transformers.

While an approximate determination of the division of load among transformers as above is most useful, at the same time it is obviously of greater importance to know exactly the load division in practice, and this can only be determined by actual measurement.

An ingenious current transformer is now on the market which in conjunction with a suitable ammeter can be used for this purpose. The transformer, which has a hinged magnetic circuit, is merely clamped around the transformer lead, and connection made to an ammeter where the actual load is indicated on the instrument. By applying this test to all transformers banked in multiple an exact knowledge of the conditions is possible. When it is found that either due to difference in impedances of the transformers or the lines (the latter as a result of non-symmetrical arrangement) that an equal and proper division of load does not exist, means should be taken to correct these conditions. This can be done either by rearranging the transformers or lines or by inserting suitable reactance coils in the transformer secondaries. Such coils can be obtained from transformer manufacturers, or, as a temporary expedient, a coil could be constructed by winding a few turns of insulated wire of the same cross-section as the transformer lead about an iron core of sheet-iron or iron wire; but a properly designed coil should be obtained from a reputable manufacturer for permanent service.

We may sum up our conclusions as follows:

1. For all practical purposes the division of load among transformers is independent of their power-factors, and depends only upon their impedances.

2. Transformers of the same or different design of the same size and impedance volts connected in multiple arranged symmetrically with respect to each other and the load, will divide the load with practical equality.

3. Transformers of the same or different design and of different sizes and the same per cent impedance volts at rated load, and arranged symmetrically with respect to each other and the load, will divide the loads in the ratio of their

rated kilowatt capacity to the total kilowatt capacity.

4. Transformers of the same or different design and of different sizes and different impedance voltages at rated load, and arranged symmetrically with respect to each other and the load, will divide their loads in proportion to their rated capacity when provided with reactances which will compensate for the inequality of impedance voltages at rated load.

5. When the transformers are not arranged symmetrically with respect to each other and the load, the line impedances affect very largely the distribution of load, in possible cases even more than the difference in impedance voltages of the transformers

6. In practice, it is almost impossible, owing to the continually changing load-centre and the complex arrangement of circuits to determine the line impedances, and provide for their symmetrical disposition, hence the only practical way of determining accurately the load division is by actual test at different periods of the day and principally under average and maximum load conditions. From such a test the circuit conditions are known accurately, and proper provision can be made by a rearrangement of transformers, lines or load; or reactances provided which will enable a more equal division of load to be obtained.

Two Prominent Electrical Men Join Forces.

Dr. F. A. C. Perrine, the well-known electrical engineer, and Mr. Henry L. Doherty, who is very well known in the management and ownership of electric lighting companies, have united offices at 60 Wall street, New York city. It is understood to be their intention, while not forming any partnership, to keep in close relation, Dr. Perrine looking after the engineering problems and Mr. Doherty developing the financial and industrial phases of the business. Dr. Perrine has been for many years a leading figure in long-distance electric-power transmission work, and Mr. Doherty, a former president of the National Electric Light Association, has a fine record of achievement in the developing of electric lighting interests, and the alliance will, no doubt, be a very successful one along the most progressive lines.

Foreign despatches announce the death, in his seventy-fifth year, of Dr. Johann Meidinger, professor of physics at the Technical Institute, at Karlsruhe.

Properties of Iron-Nickel-Manganese-Carbon Alloys.

The seventh report to the alloys research committee on the properties of a series of iron-nickel-manganese-carbon alloys, was presented before the Institution of Mechanical Engineers, of Great Britain, on November 17, 1905, by Dr. H. C. H. Carpenter, R. A. Hadfield and Percy Longmuir. The report contained, besides an introductory note and the general introduction, a description of the preparation and mechanical and heat treatment of the alloys at the Hecla Works, Sheffield, England, the heat treatment of the alloys at the National Physical Laboratory, a table of chemical analysis, and a discussion of the mechanical properties of the alloys, the physical, chemical and metallographical properties, the critical ranges on cooling, the critical ranges on heating, and the metallography of the alloys.

The following paragraphs are abstracted from this very complete report, bearing upon the resistivities and permeabilities of the alloys:

The series of nickel-manganese-carbon-iron alloys, A-K, whose properties have formed the subject of investigation of this research, has been prepared in the following manner:

The base of the material used was Swedish charcoal iron of special purity. This was melted along with the necessary ingredients, nickel and Swedish white iron. By these means approximately uniform percentages of carbon and manganese were obtained, the nickel varying from nil to twenty per cent as aimed at. The series may be taken as showing satisfactory products, as the carbon percentages were on the whole uniform. They vary from 0.40 to 0.52, 0.45 being the figure aimed at. The nickel percentages showed very little loss. The manganese percentages show a variation from 0.79 to 1.03. This element is notoriously difficult to obtain constant in any series of alloys. The exact loss on melting is shown in table I:

TABLE I.

Nickel Alloy.	Percentages Ni.	C.	Mn.	Percentage Loss of Mn. in Melting.	Resistivities Microhm Cm. at 17° C. (62.6° F.)
A	Nil	0.47	0.95	24	20.3
B	1.20	0.48	0.79	29	22.6
C	2.15	0.44	0.83	34	24.8
D	4.25	0.40	0.82	40	29.1
E	4.95	0.42	1.03	31	39.3
F	6.42	0.52	0.92	36	42.8
G	7.95	0.43	0.79	42	43.9
H	12.22	0.41	0.85	45	50.5
J	15.98	0.45	0.83	46	63.3
K	19.91	0.41	0.96	38	75.4

The original series did not include alloys E and F. These were prepared some months after the research had been in progress, when it had become evident that more alloys were necessary to fill in the gap between four and eight per cent nickel, in which range the properties of the series underwent a profound change.

The materials prepared, together with the thermal and mechanical treatment they received at the Hecla Works, were as follows: ingots, twenty-four inches by two and four-fifths inches by two and one-half inches were cast.

Half the cast ingot was forged down to a round bar, one and one-quarter-inch diameter, and from four to five feet long. A ten-inch length of this was rolled down to one-half-inch diameter round, giving about a four-foot length.[1] (This was not done in the case of A, the nickel-free alloy.) The two series of bars were sent in this condition to the National Physical Laboratory. From the one and one-quarter-inch diameter bars nearly the whole of the materials used in the various tests—mechanical, physical, chemical and metallographical—were machined, after the resistivities had been measured.

RESISTIVITIES.

The mass resistivities were determined by the Thomson double-bridge method. Measurements were made on both the one and one-quarter-inch and the one-half-inch bars, except in the case of alloys A and H, where only the one-half-inch bars were used. Very closely agreeing values were obtained in the two series. In the case of the one and one-quarter-inch bars the length tested was sixty centimetres; in that of the one-half-inch bars 100 centimetres, except in C where a fifty-centimetre length was tested. From the mass and length measurements of the bar under test, the mass resistivity was calculated. The quotient of this by the density gives the resistivity.

The results are given in table I in the form of microhm centimetre resistivity at seventeen degrees centigrade (62.6 degrees Fahrenheit), (the temperature at which the tests were made). To enable a comparison to be made with copper, the value of the standard soft copper of the Electrical Standards Committee is 1.702 microhms centimetre. The results are also plotted in Fig. 1, the coordinates being resistivity and percentage nickel. The resistivity rises with ascending nickel, the values for alloys A-D, H, J, and K lying practically on a smooth curve. Alloys E, F and G, give values above the smooth curves. These values have been doubly

[1] G and H cracked slightly under this treatment.

checked. The sudden change at E is coincident with a structural change in the series, and constitutes additional evidence of the sharp break in the continuity of the properties of the series which is manifested in the great majority of tests made.

Increase of resistivity with rise of nickel was found by Barrett in his measurements of five alloys, D, E, I, K, L, in the low carbon-nickel-iron series.[1] There was nothing examined between 3.82 and 11.39 per cent nickel, and the curve between these percentages has been drawn smoothly. It is precisely in this region that the irregularities in the authors' series have occurred. The authors' first set contained no nickel between 4.25 and 7.95 per cent, and the latter alloy was the only one that lay off the smooth curve. When alloys E and F were inserted, it was found that the slope was more irregular than had been previously indicated. This is a striking instance of the caution that is necessary in interpreting from curves the variations of properties of a series of alloys containing comparatively few members. The resistivities of alloys H to K come out high, but they do not approach the figure 97.5 found by Barrett with an alloy containing twenty-five per cent nickel, five per cent manganese and 0.6 per cent carbon. The temperature coefficients of the alloys were not determined.

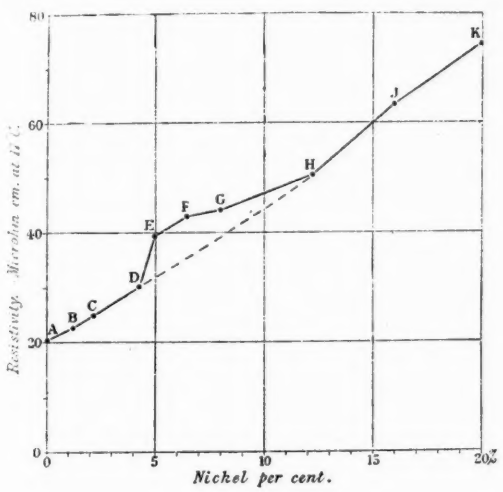


FIG. 1.—RESISTIVITIES.

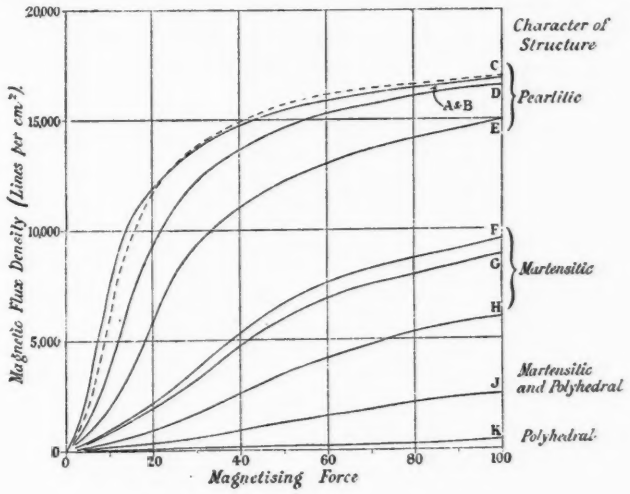


FIG. 2.—PERMEABILITIES.

MAGNETIC TESTS.

A series of magnetic tests was made on rods of the alloys by means of a Ewing permeability bridge. The rods were all cylindrical and of about twenty centimetres length and 0.713 centimetre diameter. It was found when using the permeability bridge that it was important that the bar under test should be very similar in magnetic quality to the standard bar against which the comparison was made. Thus the ideal standard in each case would be a rod whose permeability curve would approximate closely at all points to the curve for the rod under test. As the samples varied very widely in magnetic quality it would not have been easy to construct a set of standard rods agreeing all along their curves with the rods tested. The bridge, however, may be used with sufficient accuracy with rods whose curves may be widely different, provided the comparison is made only at one point, viz.: the point of intersection of the two curves. Thus, if a number of different standard bars are available, the points at which their curves are crossed by that of the bar under test can be determined and thus a more or less complete curve obtained.

In order to obtain a series of standard rods whose magnetic qualities should be sufficiently spread over the wide range required, several expedients were adopted. The standards were all made in pairs, great care being taken to get the rods in each pair as uniform as possible; they were tested for equality in the Ewing bridge, and if sufficiently near, had their approximate permeability curve determined by means of Ewing's small yoke method.

The materials for the standard bars comprised mild steel, tool-steel, grey and white cast iron, and one of Heusler's copper-manganese-aluminum alloys, the three last-named alloys being prepared in the metallurgical department. In addition to standard bars, tubes of mild steel were also used and proved efficient; they were all of the normal outside diameter, but of various inside diameters, thus giving a variety of apparent permeability curves. Tests were also made by the ordinary ballistic method on a series of small rings of all the alloys except H; the outside diameters of these rings were of the order of one centimetre. The rings were all admitted to preliminary heat treatment as similar as possible to that to which the bars had been subjected. For alloy B, the curve obtained by the ring method agreed at the lower values with the curve for the rod compared against cast iron, and at the higher values with that obtained against wrought iron. This agreement made it possible to take B as a standard, and accordingly A, C and D were tested against it, their curves being not far apart. The remaining alloys were tested against the cast iron and other standards already described. The agreements between curves obtained against different standards made it permissible to consider that the final curves given in Fig. 2 represent the actual properties of the rods to a sufficient accuracy.

Table II gives for each rod a statement of the standards against which it was tested. Some companies were also made between the rods themselves; these are included in the table.

The results of the permeability tests show how intimately these are bound up with the structures of the alloys. In Fig. 2 the structural characteristics are tabulated alongside of the curves. The four pearlitic steels show the highest permeabilities. The martensitic steels give very much lower values. K, the polyhedral steel, is the lowest of the series.

TABLE II.

Nickel Alloy.	Standards Used
A	B.
B	Soft iron and tool steel.
C	B.
D	B.
E	Mild steel tube and cast iron.
F	Mild steel tube and G.
G	Cast iron and Heusler's alloy.
H	Heusler's alloy.
J	Tool steel and mild steel tube.
K	Mild steel tube and G.

[1] Institution of Electrical Engineers, vol. xxxi No. 156, table I, also Fig. 2.

Mica—Its Occurrence, Exploitation and Uses.

A most interesting report on "Mica—Its Occurrence, Exploitation and Uses," has been issued by the mines branch of the department of the interior of the Dominion of Canada. This monograph has been prepared by Mr. Fritz Cirkel, acting under the instructions of Dr. Eugene Haanel, superintendent of mines. It comprises about 150 octavo pages, about two-thirds of which are devoted to the Canadian mica mines, the remainder being given to the occurrence and production of mica in other countries, and to the mining laws of Canada. There is also a valuable bibliography on the subject appended.

Mica is an essential material in the construction of electrical apparatus. In this use it may be ranked with copper, iron, rubber and cotton. For the particular purposes to which it is applied we have no other material which can take its place.

Mica, in its broader sense, comprises a group of minerals whose chief characteristics, distinguishing them from all other minerals, are the highly perfect basil cleavage and the great elasticity of the easily obtained thin laminæ. A mica crystal may be split into sheets, and the division continued to the thickness of one-thousandth of an inch, and could be carried, with sufficiently fine instruments, to one-three-hundred-thousandths of an inch.

Of the many different species of mica, three only are of commercial importance. Muscovite, usually called potash mica, of which the predominating color is white or yellow, constitutes most of the white mica used. Phlogopite is a magnesia-alumina mica of amber, brown and black color. This constitutes the greater part of the amber mica of commerce, as found in Canada. Biotite is magnesia-iron mica, generally black in color.

The transparency of mica sheets is often destroyed by disturbed crystallization or by impurities taken up from the solution during the process of developing. These inclusions generally appear in films or very thin plates between the cleavage planes. The most common of these in muscovite are films of feldspar, but in phlogopite the inclusions are calcite, apatite, feldspar and quartz. They are sometimes so numerous as to render the crystal entirely unfit for use.

The degree of hardness of all the micas lies between gypsum and calcite. Loose sheets of mica found in the humus, as the result of the decomposition of the crystals, are soft and have an unctuous aspect. Crystals, however, which have been subjected to earth pressure or other disturbances during crystallization deliver hard, inelastic sheets, and are not desirable for commercial purposes. Generally a high degree of hardness is looked upon with disfavor in the trade, and for electrical purposes those sheets that can be scratched with the finger nail are much preferred.

The geological occurrence of muscovite and phlogopite is confined more or less to pegmatite dikes, masses, lenses, sheets or veins, which in character may be called a very coarse granite. These dikes occur in the Laurentian formation. The pegmatites penetrate the gneiss formation along, and sometimes across, its stripe. The crystals of muscovite mica are generally scattered promiscuously through the matrix, while larger vein-like aggregations are observed near the contact of the adjacent formation.

Muscovite mica occurs throughout Canada in a large number of places. The best deposits so far discovered are those of the Saguenay district situated at the lower St. Lawrence river below Quebec. Besides these there are deposits to the north of Ottawa in the vicinity of Mattawa, at several places in Ontario, and recently discovered in British Columbia. The Saguenay river district has not been surveyed or thoroughly explored, but since 1892 constant discoveries have been made, some of them of very large extent. The mica generally found here has a dark rose color when in thick sheets.

One of the oldest, and at one time regarded as the most prominent white mica mine in the country, is the Villeneuve mine, twenty miles north of the town of Buckingham. The first work on this property was done in the summer of 1894. During the four years following, 35,000 pounds of cut marketable sheets of excellent quality were produced. Since then the property has been worked intermittently. The mine has come into prominence on account of the minerals containing rare earths which are found throughout the pegmatite dike, but no serious attempt has so far been made to extract them.

Canada is rich in economic phlogopite deposits. There are many localities in which the mica may be obtained in large, transparent sheets, free from flaws, and may be employed for the same purposes as the muscovite variety. The occurrence of workable phlogopite deposits appears to be confined solely to Canada, and more especially to an area of 520 square miles included in the country north of Ottawa. The deposits of phlogopite mica are associated with pyroxene, which penetrates the limestone in the form of dikes. Generally two classes of deposits can be distinguished: contact deposits, forming the contact between the gneiss and pyroxene; and pocket deposits, occurring in fissures wholly in pyroxene. From its formation, mica seems to indicate a crystallization from the aqueous-igneous solution along lines of fracture in certain portions of the phlogopite in conjunction with the formation of apatite. This is rendered the more probable by the occurrence of thin sheets of calcite between the sheets of mica, and by the impression of the mica sheets on fragments of well crystallized calcite; which would seem to indicate that the mica crystallized first out of the injected magma.

The work of extracting mica from the rock and converting it into a salable article is divided into the ordinary mining operations, such as drilling, blasting and hoisting, together with the collection and transport of the mica to the cobbing sheds; and second, the dressing or cobbing—that is, the separation of the mica sheets from the adhering rock particles and grading of these sheets into different sizes and qualities for transport.

On account of the irregular character of most of the mica deposits, the methods employed to work a mine are manifold. The easiest work is the open quarry, where several deposits or pockets are mined together until the remaining rock shows no more mica. This method is disadvantageous because work can only be performed in mild weather. Work underground has therefore many advantages, the principal one being the possibility of continuous operation. In the case of a vein-like deposit with defined walls, a shaft is usually sunk, and the deposit opened up at intervals of thirty to fifty feet. In the case of pocket deposits, an inclined shaft for the hoisting of raw material is put down in the surface deposit, and all the mica in sight is taken out; then the shaft is continued and drifts are run in all directions in the hope of finding other deposits.

The peculiar location of the mica crystals either singly or in accumulations, in the rock matrix, makes a certain position of the holes imperative if the thin sheets are to be unimpaired; and generally, this position can not be attained by rock drills. Hand drilling therefore is the rule, and the holes so drilled are only slightly loaded, the object being just to

loosen the rock preparatory to taking it down by picking. This drilling is generally performed by three men on each hole, two striking and one turning the drill. In the larger mines, the development work is done by steam or compressed-air drills. While in the larger mines the blasts are fired by electricity, in general fuses and caps are employed. Though the latter practice is more or less dangerous, it has advantages, inasmuch as the firing in single holes in succession can be regulated easily. After a blast the broken rock is removed to the dump, and the mica crystals picked up. This work is generally done by a boom derrick, or in some cases by an inclined cable hoist.

The cost of mining mica varies considerably with the locality. A case said to represent average conditions is quoted, where the daily expenses are $47.65, and the average daily output of the mine is sixty tons of rock and 600 pounds of trimmed mica, cutting from one by three inches up. One ton of trimmed mica, of sizes from one by seven inches upward, is thus produced at an average cost of less than $179. This includes nothing for prospecting and exploring, which, in nearly all cases, is carried on simultaneously with the mining.

Experience has shown that for a mine to pay, under present conditions, at least 750 pounds of trimmed mica must be extracted for 100 tons of rock, in mines of the quarry class; and in underground mining the output must be at least 1,250 pounds of trimmed mica for every 100 tons of rock mined.

Generally speaking, a deposit of fairly good quality should yield as an average about fifty per cent of the mica sheets in sizes cutting one inch by three inches; thirty per cent cutting two by three inches; ten per cent two by four inches; six per cent three by five inches, and four per cent four by six inches, and over.

An important development of recent years was that of micanite. Ten years ago sizes of mica less than two by four inches were hardly salable, and were generally discarded. To-day sheets of this size have a good market value for the production of micanite, which is a board built up of thin laminæ carefully laid together and cemented. This development gave value to considerable piles of small sheets which had been thrown away in previous years.

The mica sheets, after being delivered to the cobbing sheds, are split up into plates about one-sixteenth of an inch thick, by means of a short-handled knife sharpened toward the point on both edges. The rough edges of the mica are thumb-trimmed, and the sheets graded. An important feature of the trimming and dressing operation consists of splitting the mica for the purpose of removing the damaged films, and layers or inclusions of foreign materials. This part of the dressing requires good judgment. One person can clean and trim from thirty-five to forty-five pounds of medium-sized sheets in ten hours. The trimmed sheets are then packed in sizes firmly into a barrel—generally a sugar barrel—holding about 325 pounds. These barrels are shipped to the trimming works, where the sheets are more carefully resorted, all of those showing defects being rejected. The selected plates are split again, and then trimmed by machine knives.

Sheets of less size than one by three inches can not be used at present, but there is a movement on foot to make use of this material of which there are considerable stores. The waste or scrap mica—the refuse of the cobbing sheds—is now ground to a fine powder for the standard sizes of from 20 to 200 meshes to the inch, and is used for preparing paints and other specialties.

The mining of mica in Canada is still a young industry, and has only recently assumed a prominent position. Formerly the work was carried out unsystematically, and there was no attempt to keep reserves in order to meet sudden demands. This policy has since been generally adopted. The future outlook for the production of a large tonnage is bright, and if Canada should ever be called upon to furnish the world's supply of mica, the mica fields of Ontario and Quebec could soon be prepared for such an emergency. There are at present employed in the mica industry 550 persons. The wages paid last year amounted approximately to $120,000. It is estimated that the total outlay for plant, including buildings and all accessories, amounts approximately to $160,000. The value of the yearly product for 1903 was $176,334, and the total value of the mica produced in Canada up to the beginning of 1904 is approximately $2,000,000. Most of the mica is absorbed by the United States, although an effort has been made to create a market in England.

The perfect cleavage of mica, yielding thin, smooth, transparent sheets of great flexibility and elasticity, its chemical stability, and above all, its non-conductivity, are physical properties which no other material unites to the same extent. Mica has been an article of commerce for several hundred years. It is used for windows and lanterns, particularly where the light is exposed to the weather. It is used for glasses and spectacles to protect workmen from flying particles; in miners' lamps in order to avoid breakage; for paints, wall paper and ornamental uses; but its most extensive use, especially of the Canadian amber variety, is for electrical insulation. The qualities required for electrical purposes are as follows: it must split easily without cracks and tears; it must be flexible and soft. The most valuable property of Canadian mica is its electrical non-conductivity. Its market value is based on its freedom from streaks and iron stains. The insulating power of mica is superior to that of any other substance applicable to armature construction. Its hardness prevents its wearing away too rapidly in commutators, and it is not affected by the highest temperature to which it is thus exposed.

Samples of Canadian mica sent to England were exhibited to experts, who said that for electrical purposes the mica was superior to most of the Indian mica that reaches that country.

Scrap mica is also being used now to form heat-insulating coverings for boilers and pipes, for which purposes it is excellently adapted.

Mica is found in other countries, principally in the United States and in India. The chief localities in this country are New Hampshire, North Carolina and South Dakota. A deposit of mica has been reported also from Alabama. Mica occurs in Brazil in workable quantities. In Norway there is a deposit of mica having a peculiar character, as the plates split out of a crystal are thicker at one end than at the other. China is reported to have vast untouched deposits of mica at Kiao-Chau bay.

India ranks foremost among the mica-producing countries of the world. It employs more persons in this class of mining than any other, and the area covered by mica deposits is the largest so far known. In the year 1902 there were employed in mica mining in India 9,500 persons, while the production and sales during the same year were 685 tons, valued at $507,770. This output is supposed to come from 200 mines. Most of the mica deposits are of a pockety nature. Their occurrence is very irregular, and the methods of production are exceedingly crude. The mica of commerce occurs almost exclusively in pegmatite veins. The system followed is to open cuts along the outcrops of the mines where mica crystals are found, and

to alternate with cross-cuts at right angles through the vein formation. The work is done by building fires against the rock, heating it to a high temperature, and then throwing water upon it. The cracks thus formed are widened by wedges, and the rock broken out. The material is raised to the surface by rows of native women placed along the inclined opening, who pass buckets filled with mica from hand to hand, or pitchers filled with water for draining the works. The rough sheets are crudely trimmed by a knife, done up into packages, and carried by carts to the shipping points. The wages paid are low, the women getting about six cents a day, the men about eight, and the overseers about sixteen. Although Europeans have become interested in the Indian mines during recent years, the work is still carried on in the old way with possibly a few exceptions.

The world's production of mica for the year 1902 was valued at $904,139. Of this $507,770 is credited to India; $242,310 to Canada; $98,859 to the United States, and the remainder to Brazil and other countries.

Municipal Ownership in Edinburgh, Scotland.

Consul Fleming, of Edinburgh, furnishes the following on the operation, by the municipality of that city, of tramways and electric lighting:

"EDINBURGH TRAMWAYS.

"Prior to 1893 the tramways in this city (all horse-car lines) were owned by a private company. In that year they were purchased by the municipal corporation for $1,654,610, and in the following six years were converted to the cable system. The total cost of the 21.68 miles (double) of cable tramways, including equipment, power-houses, street widenings and purchase price to the private company, was $6,326,450. The entire system was leased to a private company in 1899 at a rental of seven per cent of the total expenditure of the city on tramways account, the lease fixing the maximum rate of fare to be charged on the basis of two cents per mile. The lines have been yielding a net profit of considerably over £100,000 ($486,650) per annum. For the current year the gross receipts are expected to exceed £258,000 ($1,240,957). In regard to the value of the tramways to the corporation, the town clerk of Edinburgh says:

" 'The results attest that the undertaking has capacity for expansion of traffic and forms an asset of enormous value. With the exception of a sum of $26,765 per annum, which is paid out of the tramway rent as a contribution to the city rates in lieu of rent for the streets, the net rent is being applied in meeting the interest and providing a sinking fund for redemption of the tramway debt. If that course is continued until the lease terminates, the greater part of the tramway debt will have been redeemed from the tramway revenue. If the same traffic could have been carried on, and presumably the same profit earned, by a system which cost only one-half of the cable expenditure, then the lessees would have had upward of $194,660 per annum of clear profit which they now pay in rent to the corporation. It is not so much the corporation as the lessees who are to be commiserated, if it be the fact that one-half of this expenditure was unnecessary. The lessees plainly do not believe this. With care in the selection of tramways to be constructed and prudence in capital expenditure there is every prospect that the result will vindicate the wisdom of the corporation in keeping the ownership of the tramways in their own hands and not giving it up to companies. The city rates have not been called upon to pay anything for tramway purposes, but, on the contrary, they have received about $194,660 in contributions to the rates, in addition to being relieved of the expense of certain street widenings, and of the formation and maintenance of the streets, so far as within the tramway rails and a certain distance outside.'

"The fares charged by the operating company average somewhat less than two cents a mile for distances exceeding one mile. For short distances—one mile or under—the charge is two cents. Roughly speaking, tramway fares are from fifty to sixty per cent higher in Edinburgh than in Liverpool or Glasgow.

"ELECTRIC LIGHTING.

"Of the public utilities in this city only one is carried on by the municipal corporation, viz., electric lighting. This undertaking has now been in operation for ten years. For the twelve months ended May 15, 1905, the net capital expenditure was $252,865 (the total capital expenditure for the entire period of ten years being $4,366,686); revenue for the year, $578,867; costs, excluding interest and sinking fund payments, $235,886; interest on capital expenditure, $104,079; sinking fund for repayment of capital expenditure, $136,018; net profit before placing anything to reserve fund, $102,884; reserve fund, $83,192; units sold, 11,648,501; total cost per unit sold, excluding interest and sinking fund, 1.998 cents; price charged per unit for private lighting, seven cents; for power two and one-half cents; for public street lighting, $53.53 per arc lamp per annum; number of arc lamps, 998; number of eight-candle-power lamps connected, 743,331; number of consumers, 8,334. Of the net profits, the sum of $19,695 was credited to city rates and taxes.

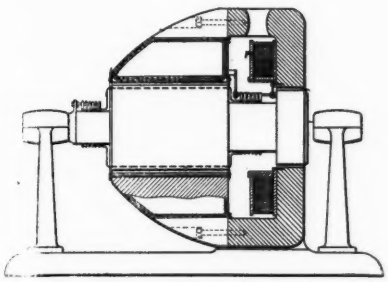
"In 1896 the charge for private lighting was twelve cents per unit, for power seven cents per unit, and for arc lamps $97.33 per lamp. By the act of parliament authorizing the electric lighting scheme, the corporation is empowered to provide a reserve fund and accumulate the same until the fund amounts to one-tenth of the aggregate capital expenditure, which shall be applicable to answer any deficiency at any time happening to the income of the undertaking, or to meet any extraordinary claim or demand arising against the undertaking. This reserve fund now stands at $379,580."

A Large Electric Crane.

The United Railways and Electric Company, Baltimore, Md., has received several parts of one of the largest traveling cranes in the world. The machine is intended for use in the addition to the power-house on East Pratt street. The crane was built by the Morgan Engineering Company, of Alliance, Ohio. It has a capacity of fifty tons, and will be operated entirely by electricity. The runway will be built ninety feet above the floor of the building. The immediate purpose of the lifting machine is to place in position the heavy machinery which is being provided for the new power-house. After the conflagration at Baltimore, the city took sixty feet from the United Railways company's Pratt street property in order to widen that street to 120 feet. The addition the company is now constructing was arranged to meet this emergency. The new structure is of steel, with brick and stone facings, and has foundations of reenforced concrete. The building is 140 feet square and 110 feet high. The steel work is completed, and the brick work is now up to a considerable height. It is desired by the company that the contractors have the building under roof by January 1, or very soon thereafter. The company now has three engines under a temporary shelter facing Pratt street, and it is desired to get these in the permanent building as soon as possible. These engines are now in daily use supplying current for the running cars. It is thought that after the holiday rush they may be shut down long enough to permit their removal to the permanent locations in the new building. The officials are exerting themselves to have this done on or before February 1. Provision has already been made for a fourth generator and engine, with a capacity of 7,500 horse-power.

Electrical Patents.

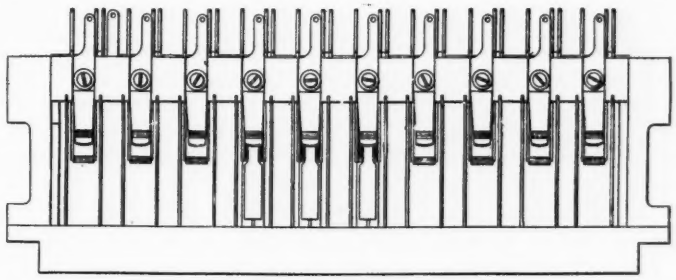
Charles P. Steinmetz, Schenectady, N. Y., has assigned to the General Electric Company a patent recently granted to him on a dynamoelectric machine (804,440, November 14, 1905). The invention relates to dynamoelectric machines of the type known as "homopolar." The use of steam turbines as prime movers is rapidly removing the objection to the use of homopolar machines based on their low voltage, since with sufficiently high speed such machines may be designed for commercial purposes without an undue number of collector-rings, while the absence of a commutator makes them particularly suitable for high speeds. One object of the invention is to provide a



DYNAMOELECTRIC MACHINE.

novel form of homopolar machine in which the second objection shall be met by the elimination of the armature reaction, which has hitherto rendered the regulation of such machines too poor for service where constant potential is required. In the embodiment of the invention a drum-armature is provided, carrying at or near its periphery a plurality of conductors. A field structure has a plurality of like poles extending radially inward and surrounding the armature, the poles extending into close proximity to each other adjacent to the armature so as to form a "homopolar" field and diverging from each other as they recede from the armature.

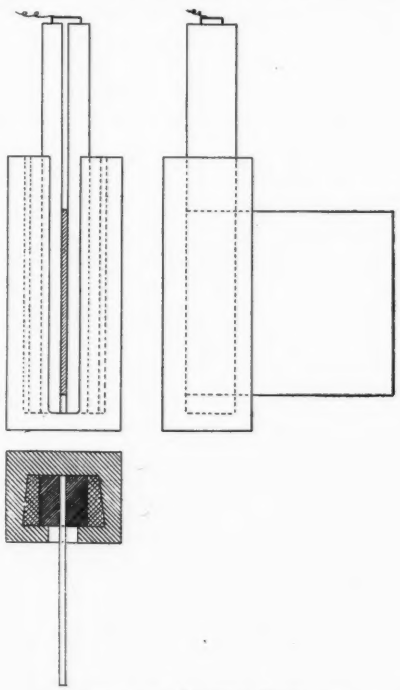
The Stromberg-Carlson Telephone Manufacturing Company, Rochester, N. Y., owns a patent granted to Thomas V. Davis, Kansas City, Mo., on a telephone switchboard apparatus (804,103, November 7, 1905). The invention relates to switchboard apparatus, and its object is the provision of an improved device for coloring or intercepting in various ways the rays emanating from a visual signal employed on a switchboard whereby to indicate to the operator the line or circuit with which the visual signal is connected. It is very desirable to indicate to the operator what class of subscriber is connected with a particular signal, for instance, whether the subscriber be connected with a grounded line or a metallic line or a party line; and the invention is incorporated in a device in the shape



TELEPHONE SWITCHBOARD APPARATUS.

of a thimble which may be inserted in openings extending through the front of the switchboard in alignment with the visual signals. Various colored screens are provided which may be secured in the thimble to color the rays of light, and screens are also provided with openings of different shapes, which screens may be inserted in the thimble. These screens may be of colored transparent material or may be opaque. Instead of using the colored screens or the perforated screens alone, a combination of the two might be used.

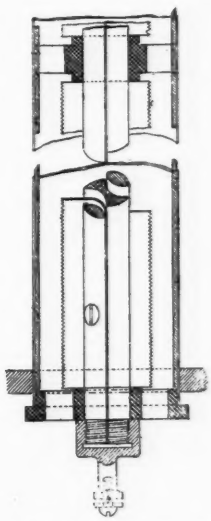
Franz Petz, Nuremberg, Germany, has patented in this country a process for



PROCESS FOR MAKING CONTACTS.

making contacts (804,429, November 14, 1905). The invention is particularly directed to a novel process of making good electrical contact between metallic conductors having the form of strips or plates and which, owing to the peculiar character of the material, can not be soldered or secured together by screws or similar devices. The process consists in making good electrical contact between a metallic conductor and two relatively fragile non-metallic conductors by enclosing the metallic conductor between the two non-metallic conductors in a confining space and subjecting the enclosed conductors to the compressive action of an adhesive material which expands on solidifying.

An electrical apparatus for producing ozone is the subject matter of a patent issued to Albert C. Wood, Philadelphia,



ELECTRICAL APPARATUS FOR PRODUCING OZONE.

Pa. (804,291, November 14, 1905). The invention is designed to provide improved means for producing ozone by discharging a high-tension electric current in an atmosphere of oxygen, and particularly to produce an apparatus having improved electrodes and holders therefor. In this apparatus a tubular conduit is provided in which is located an electrode, composed of sheets of metal bent to form diverging branches. An insulating-support is employed for the electrode which is freely movable in the conduit and has apertures therethrough. Other insulating-supports for the electrodes fit in the ends of the conduit and have apertures therethrough. A conductor is also connected with the conduit.

Reviews of Current Engineering and Scientific Literature.

On the Dimensioning of Single-Phase Commutator Motors.

Although, in the last year or two, a number of articles have been published on the operation of single-phase motors, and their behavior has been discussed frequently, but little has been said about the proper dimensioning of these machines, attention being principally directed to their physical characteristics. In this section of a continued article M. J. Bethenod considers the single-phase commutating motors with a view to determining the most suitable dimensions. Three types of motors are to be considered—the single-phase, the repulsion motor, and the mixed, or Latour motor. The first type only is taken up here. In considering these motors as applied to traction purposes, three qualities should be possessed in marked degree: there should be a large starting torque for the kilovolt-amperes absorbed; the power-factor at full-speed must be large, and commutation must be acceptable. To approach the subject understandingly, the author makes use of a factor giving a simple relation between the torque and the apparent power absorbed, and states that this factor must be high. In order to avoid a coefficient involving dimensions, the torque is referred to the synchronous speed, as is generally done for induction motors. Taking up the series motor, two arrangements are available: one in which a compensating winding is placed on the stator and short-circuited upon itself; in the other the compensating winding is connected in series with the main field-winding and the armature. Considering first the short-circuited compensating type, it is shown that the tangent of the angle of lag is simply proportional to the angular speed, and it is clear that the dimensions giving the smallest value to this tangent will be equally the best for all other conditions. The author then shows that the minimum value for the tangent is obtained when the ratio between the inductance of the stator and the rotor is equal to the leakage coefficient of the rotor. This is the ratio giving the best power-factor. He shows also that the best value for the coefficients suggested above will be obtained by the dimensions which give the best power-factor. It is shown, however, that under these conditions there is a magnetic field set up under the commutating brushes, and therefore commutation may not be satisfactory. It is this inconvenience of this method of winding that has brought the series system into favor. Taking up next the series system, the author shows that his coefficient will have its maximum value, as before, when the power-factor is a maximum; but the power-factor in this case is smaller than that for the short-circuited type of winding, if a perfect compensation is obtained. He shows also that the compensating winding may be dispensed with by displacing the brushes against the direction of rotation by a certain angle, and that this angle is in the neighborhood of ninety degrees. The minimum value for the angle of the tangent of lag will be given when the ratio of the inductances of the stator and rotor is equal to unity. With this arrangement a value for the coefficient above referred to is obtained identical with that given by the short-circuited winding.—*Abstracted from L'Éclairage Électrique (Paris), November* 11.

Electrical Control.

An ingenious method of controlling apparatus from a distance by means of electric motors is here discussed by M. Emil Du Bois. The system has been devised to give a delicate and perfect control of any apparatus, such, for example, as a searchlight, which, in order to follow the movements of vessels, must be capable of very exact adjustment, and also be able to move quickly through a wide arc. The system devised makes use of the Wheatstone principle. A resistance corresponding to two branches of the bridge is placed at the control point, and a similar resistance is placed at the apparatus to be controlled. A relay connected in the usual galvanometer position will then move its armature in one direction or the other, accordingly as its point of contact on one arm of the bridge is changed in one direction or the other, and this movement will be sustained until the movement of the apparatus under control has shifted the other end of the relay circuit so as again to bring about a balance. The bridge arms in M. Du Bois's system are made up of two rheostats, each divided into twenty parts, and arranged with their connecting terminals in two circles. Connection is made to these by two revolving arms geared together, so that one makes a complete revolution, thus passing over the twenty steps of the rheostat, while the other arm moves from one segment to the next. In this way 400 steps are obtained in the control motor, and a delicate adjustment is possible. To provide for both rapid and slow movements, two relays are provided, one of which is actuated by the rapidly moving contact arm, and the other by the slowly moving. The first of these relays throws a switch and starts the motor at full speed, and this switch is kept closed until a similar position of the slowly moving arm is reached at the motor itself. But this does not necessarily correspond to a balance, since the rapidly moving arms may not be in the same position. Here the second relay comes into action, and by closing a circuit connects a resistance in parallel with the motor armature, thus cutting down the speed considerably, though still giving ample torque. The speed of the motor at once decreases and allows the final adjustment of the apparatus to be made slowly. The relays by which these adjustments are made resemble small shunt motors, except that the armature is arranged to oscillate and not revolve. These armatures are slotted to receive the coils, but to avoid the jerky movement which would follow as a tooth approached a pole tip, the slots are omitted at this part of the periphery. This apparatus is sensitive, responds quickly to the movements of the controlling arms, and is not affected by vibrations such as are encountered on shipboard. The author then explains the method of computing suitable resistances for the controlling rheostats, and shows how they should be divided.—*Translated and Abstracted from L'Industrie Électrique (Paris), November* 10.

Wave Shapes in Three-Phase Transformers.

The voltage-wave of a three-phase generator contains no harmonics having a frequency of three or multiple of three times the fundamental frequency, and, says Mr. R. C. Clinker, it is also clear that the current in a three-phase line carrying a balanced load can not contain a triple harmonic, as otherwise the sum of the instantaneous currents would not equal zero. A consideration of these properties of a three-phase circuit leads to interesting conclusions regarding the magnetizing currents of transformers connected to such a circuit. If the transformer be connected to a single-phase circuit, having a sine wave of electromotive force, the

induction in the core will also have a sine wave, and the current wave will contain a third harmonic produced by hysteresis in the iron. This harmonic will always be present and increase rapidly as the saturation increases. A three-phase line can not supply this harmonic, and if the transformers are delta-connected, the harmonic will circulate only in the delta; but if star-connection is used, the induction curve must be modified so as not to require the triple harmonic of current. This modification of the flux is equivalent to the introduction of a third harmonic or flux and of voltages across the terminals of the transformer. The following conclusions may, therefore, be drawn: first, that the electromotive-force wave across each leg of a set of star-connected transformers will have a different shape from that across the lines; second, the core loss of a star-connected transformer may be different from that of the same transformer delta-connected at the same voltage. The author conducted some tests to verify these conclusions. He connected the low-tension sides of three single-phase, twenty-kilowatt transformers in star, and joined up the terminals to the low-tension sides of three star-connected, fifteen-kilowatt transformers, whose high-tension windings were left open. The primaries of the first set of transformers were connected in delta to a generator supplying a sine wave electromotive force. By a suitable arrangement, a Hospitalier ondograph could be inserted either in one of the line wires or in the wire connecting the neutral points of the two sets of transformers, or across a coil of either set of transformers. In this way the current and electromotive-force waves were obtained which agreed with the theory as discussed. The current wave in one line, when the neutral wire and one of the others were open, thus giving a single-phase condition, showed the well-known form where the third harmonic is prominent. Upon closing the switches so as to obtain three-phase conditions, the current wave immediately changed, the third harmonic practically disappearing. Moreover, the maximum value of this wave was reduced about twenty-five per cent, showing that the maximum flux has also been reduced. The curves for the electromotive-force wave were taken. That obtained on the low-tension side of the transformers connected to the generator was a sine wave corresponding to the wave of the generator; but that obtained across the low-tension side of the other set of transformers contained a strong third harmonic. It has a forty per cent larger maximum, and is nine per cent less in area than the generator wave; hence the maximum induction is decreased by nine per cent, and the hysteresis loss by fifteen per cent. The author then plots the hysteresis loss characteristics for these transformers against a variable voltage. With the neutral wire open, the loss is considerably less than when it is closed, and even when this is plotted on a basis of equal line voltages, there is still less loss than when the neutral is closed. The wave distortion shown by the curves occurs in practice only with the star-connection on both primary and secondary. A delta-connection on either winding at once provides a circuit for the triple harmonic, and allows the voltage-wave on each transformer to become similar to that of the generator.—*Abstracted from the Electrician (London), November* 10.

Lead-Covered Wiring.

The advantages and disadvantages incident to the use of lead-covered wiring for inside work are here discussed by Mr. John A. Mackenzie. The advantages are that the wire comes to the contractor provided with its metallic sheathing, and generally requires no further protection. This sheathing is water-tight, and the whole installation can be made so too. The wire is flexible, and can thus be installed with little damage to the buildings; and the loop system of wiring must be adopted because of the difficulty of making joints. The disadvantages of the wire are due to its liability to damage which may occur during erection or after it has been put in place. These injuries are nearly always due to carelessness either of the workmen or of the wiremen who follow them, and they can be largely avoided if certain precautions are adopted. Lead wiring is generally assumed to be liable to damage by the wireman who is apt to cut through the insulation when stripping off the lead; but the author says that during seven years of work with this material, he has come across three instances only when such damage occurred. The same is true in regard to damage from nails or tools of men following the workmen. Damage due to rodents cutting through the lead occurs but seldom. One disadvantage is that a damaged wire can not be removed easily, but this is got around by the author, who places thin, close-jointed tubing in such places as must be plastered up, and runs the lead-sheathed wire through this. He thus obtains all the advantages of the conduit system as well as those of the lead-covered wire. He has never had any trouble due to the changes in temperature which are supposed to cause the lead sheathing to expand with heat, leaving it thus expanded when the temperature falls. To prevent electrolytic troubles, the sheathing should be bonded together at frequent intervals, using for the connections a solder containing a large proportion of lead. After adopting this practice he has had no trouble from electrolytic action, even in damp situations. This method of bonding also prevents damage to the lead sheathing when carrying heavy currents, as it provides a sufficiently conducting path to melt the fuses before the lead sheathing. The chemical action due to impure water or bad air is thought to be no more troublesome with lead-sheathed wire than it is with enameled conduits, which rust through in a short time. It is good practice to coat the end of the wire where it passes into a joint box with some insulating compound. This increases the resistance of the work, and prevents current from creeping along the insulation to the lead. Lead-covered wire should not be laid in iron pipes, as the sheathing is apt to be badly damaged in drawing it through the pipes, and this causes the wire to break down. It is better to use wood troughs or smooth earthenware conduits where the wire must be drawn through.—*Abstracted from the Electrical Review (London), November* 10.

A Suspended Electric Railway for Berlin.

The need of greater rapid transit facilities in Berlin is considered in an interesting article in the *Elektrotechnische Zeitschrift* (Berlin), October 26. This shows how the population is increasing, and is being distributed, and points out the need for additional facilities, particularly in a north and south direction. The article then discusses the suitability of the suspended electric railway for meeting the situation.

American Electrochemical Society.

The New York section of the American Electrochemical Society held its meeting on November 23, at the rooms of the Electrical Testing Laboratories, Eightieth street and East End avenue, New York city. An address of welcome was delivered by the president of the laboratories, Mr. John W. Lieb, Jr. Addresses were also made by Mr. Wilson S. Howell and Dr. Clayton H. Sharp.

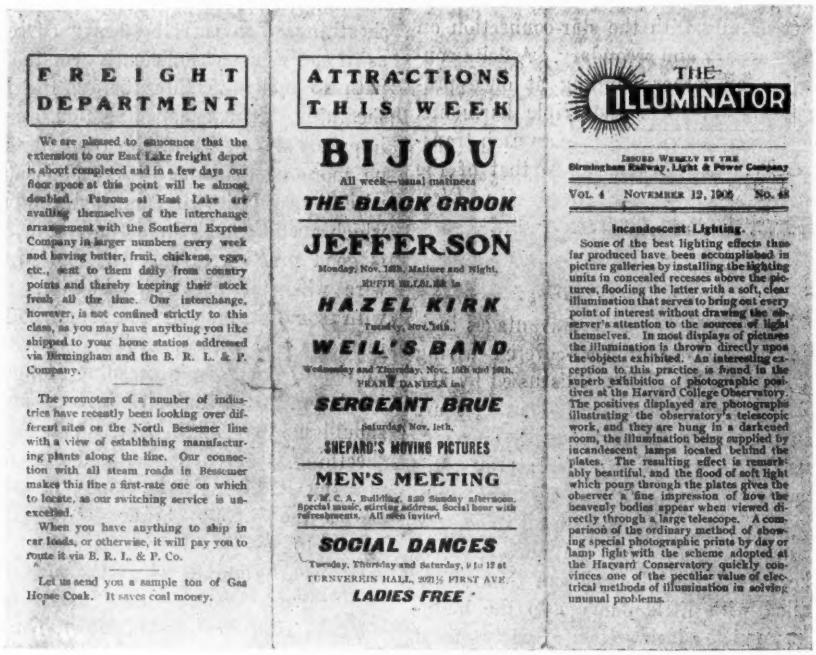
Methods of Getting New Business.

A department devoted to the commercial development of Central Stations. Managers are invited to contribute suggestions for methods of increasing the demand for electric service.

The Birmingham Railway, Light and Power Company, Birmingham, Ala., has a wide-awake publicity department under the direction of J. M. Ritson, superintendent of the sales department. The company handles four articles of supply: gas, coke, steam and electricity. In going after business, the company arranges its forces according to a well-defined plan. After making a house-to-house canvass, using a card-filing system, the territory was divided and a certain district was assigned to each solicitor. The duty of this solicitor was to keep in touch with consumers and prospective customers in his particular territory.

Space is reserved in the daily newspapers, and the advertisements of the company are varied weekly. This space is enlarged to a half-page semi-monthly, and once a month an entire full page is used. At these times illustrations of the many electrical novelties are employed.

The company distributes illustrated booklets descriptive of gas and electrical appliances, this distribution being done in the main by the solicitors in their respective territories. In addition to this, the company distributes each week a copy of the "Illuminator," a small folder printed on ordinary paper stock, which is placed in street cars, where a great variety of people may be served. This, the company states, is a very popular form of advertising.



FREIGHT DEPARTMENT

We are pleased to announce that the extension to our East Lake freight depot is about completed and in a few days our floor space at this point will be almost doubled. Patrons at East Lake are availing themselves of the interchange arrangement with the Southern Express Company in larger numbers every week and having butter, fruit, chickens, eggs, etc., sent to them daily from country points and thereby keeping their stock fresh all the time. Our interchange, however, is not confined strictly to this class, as you may have anything you like shipped to your home station addressed via Birmingham and the B. R. L. & P. Company.

The promoters of a number of industries have recently been looking over different sites on the North Bessemer line with a view of establishing manufacturing plants along the line. Our connection with all steam roads in Bessemer makes this line a first-rate one on which to locate, as our switching service is unexcelled.

When you have anything to ship in car loads, or otherwise, it will pay you to route it via B. R. L. & P. Co.

Let us send you a sample ton of Gas House Coak. It saves coal money.

ATTRACTIONS THIS WEEK

BIJOU

All week—usual matinees

THE BLACK CROOK

JEFFERSON

Monday, Nov. 16th. Matinee and Night. RIFFIN BLEEK in

HAZEL KIRK

Tuesday, Nov. 17th.

WEIL'S BAND

Wednesday and Thursday, Nov. 18th and 19th. FRANK DANIELS in

SERGEANT BRUE

Saturday, Nov. 14th.

SHEPARD'S MOVING PICTURES

MEN'S MEETING

Y. M. C. A. Building, 3:30 Sunday afternoon. Special music, stirring address. Social hour with refreshments. All men invited.

SOCIAL DANCES

Tuesday, Thursday and Saturday, 9 to 12 at TURNVEREIN HALL, 2021½ FIRST AVE.

LADIES FREE

THE ILLUMINATOR

ISSUED WEEKLY BY THE Birmingham Railway, Light & Power Company

VOL. 4 NOVEMBER 12, 1906 NO. 48

Incandescent Lighting.

Some of the best lighting effects thus far produced have been accomplished in picture galleries by installing the lighting units in concealed recesses above the pictures, flooding the latter with a soft, clear illumination that serves to bring out every point of interest without drawing the observer's attention to the sources of light themselves. In most displays of pictures the illumination is thrown directly upon the objects exhibited. An interesting exception to this practice is found in the superb exhibition of photographic positives at the Harvard College Observatory. The positives displayed are photographic illustrating the observatory's telescopic work, and they are hung in a darkened room, the illumination being supplied by incandescent lamps located behind the plates. The resulting effect is remarkably beautiful, and the flood of soft light which pours through the plates gives the observer a fine impression of how the heavenly bodies appear when viewed directly through a large telescope. A comparison of the ordinary method of showing special photographic prints by day or lamp light with the scheme adopted at the Harvard Conservatory quickly convinces one of the peculiar value of electrical methods of illumination in solving unusual problems.

The company does not give free lamp renewals, but allows a rebate of five cents on all old lamps returned when an equivalent number of new ones is purchased.

A well-organized complaint department and information bureau has been established, and information is furnished concerning sales, terms, etc., and contracts are made and complaint orders received. All complaints are issued systematically to other departments, where they are investigated and corrected. Memoranda, with results, are then returned to the information and complaint department. Special men are employed for the adjustment of such complaints as excessive bills and errors in meter readings.

The company, at various times, makes use of circular-letters, calling attention to

TROLLEY TATTLE

On the Jungle Line.

"Did you hear about the work of the leopard as a spotter on the trolley line," asked the kangaroo of the hippopotamus.

"No. What did he do?"

"He discovered that the giraffe, who was conductor, was permitting the elephant to carry his trunk in the car without checking it."

"And what happened?"

"O, the giraffe got it in the neck, of course."

The true way to get happiness is to make others happy. This is a simple and certain plan, and it costs nothing. Try it.

Working Off the Pressure.

Visiting Aunt—"Laura, I wouldn't let a husband of mine talk to me as George has just been talking to you."

Mrs. Ferguson—"Why, auntie its a relief to hear him. The telephone between the house and his office has been out of order and working abominably all day long."

Never lend a gun to the man with an aimless existance.

Relieved Himself.

Judge—"You are charged with profanity."

Prisoner—"I am not."

Judge—"You are, sir. What do you mean?"

Prisoner—"I was, but I got rid of it.—Cleveland Plaindealer.

Gas Lighting & Gas Stove Department

Your Bath Room

Is no good to you without hot water, unless you are a cold water advocate, and the best way to have a supply always ready is to let us install a rotary heater in your kitchen which will supply hot water all over the house wherever the pipes run. The air in your bath or dressing room ought to have the chill taken off—a Gas Heater is the very thing. Low in cost, cheap to operate.

Phone 18. Ask for Sales Department.

RAILWAY DEPARTMENT

This year, like last, is very prolific in nuts, and as the latest health faddists recommend them as food of the most nourishing kind, there is no reason why we cannot all become healthy and strong. In all the surrounding woods hickory nuts, scaly barks, chinkapins, walnuts, chestnuts and other varieties can be picked up by the bushel, and there is nothing more enjoyable than a trip to the woods these crisp autumn days. The air is so invigorating that it makes exercise a pleasure and not a burden; the coloring of the foliage is pleasing to the eye, and altogether one could not do better, from any point of view, than take a day off and go nutting. Many of our lines will take you right into the woods and others quite close. The North and South Bessemer lines offer the best chances for securing a good supply of nuts, and the Highland Avenue Gate City and North Birmingham lines take you within a short walk of good nutting grounds.

Manana (Tomorrow).

My friend, have you heard of the town of Yawn,
On the banks of the River Slow,
Where blooms the Waitawhile flower fair,
And the none-time-or-other scents the air,
And the soft Go-easys grow?

It lies in the valley of What's-the-use,
In the province of Let-besides,
That old "tired feeling" is native there—
It's the home of the listless I-don't-care—
Where the Put-it-offs abide.

The Put-it-offs smile when asked to pay up,
And they say, "we'll do it tomorrow";
And so they delay from day unto day,
'Till death slides up and steals them away,
And the Creditors beg, steal or borrow.

The company does not do any free house wiring, but has this done by the different contractors in the city, first submitting bids for approval to the consumers, and allowing them to pay for the installation on the instalment plan. The first payment and following instalments depend on the cost of the wiring. The cost of wiring on these terms is limited to $30, and is to be paid for within a year's time.

any new venture or novelties, and these letters are invariably followed with a visit from the regular or special solicitor.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Some Types of Machine Motor Rheostats.

One of the most important parts of a machine-tool equipment is the controller, and on its proper design depends in a large measure the successful operation of the complete motor drive. The best results can be obtained only when the motors and controlling apparatus are designed in conjunction. In this connection the General Electric Company has made a thorough study of both motors and controlling apparatus for machine-tool drives, and following is a brief description of several dial-type controllers from the many manufactured by this company.

FIG. 1.—TYPE SF CONTROLLING RHEOSTAT, NON-REVERSE.

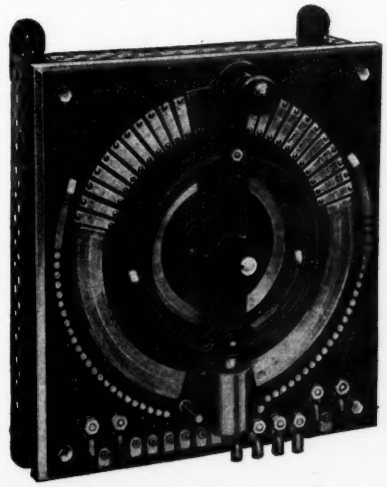


FIG. 2.—TYPE RSF CONTROLLING RHEOSTAT, FULL REVERSE.

In general, motor speeds may be controlled either by variation of resistance in shunt-field circuit, or the insertion of resistance in series with the armature circuit. Two forms of controllers of the first-mentioned variety, made by the General Electric Company, are known as types SF (non-reversing style) and RSF (reversing style). (See Figs. 1 and 2.) Those are compact speed-regulating rheostats, and are made for motors of capacities from one-quarter to fifteen horse-power inclusive, 110, 220 and 500 volts, and designed for 2:1, 3:1 and 4:1 speed variation by field control. In all sizes of these controllers the field resistance is self-contained and is within the controller; in large sizes the armature resistance is external. The reversing style has the same number of contact points for either direction of speed. Above three horse-power a magnetic blowout coil is connected on the back of the controller front to protect the first starting points from burning, while in the non-reversing style (Fig. 1) this is accomplished by an auxiliary quick-break device. Renewable segments are used for all starting contacts in both reversing and non-reversing styles. Variation in speed for these types is obtained entirely by field control, and the armature resistance is not designed for continuous service, although it is liberally rated and will stand unusually severe service without injurious heating or burning.

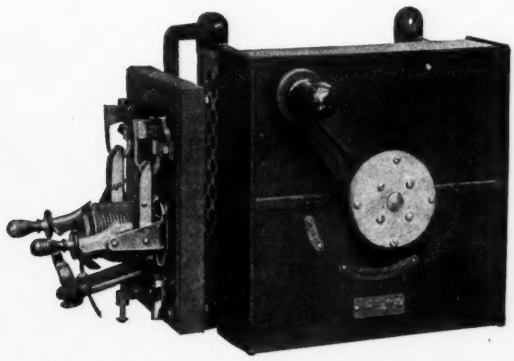


FIG. 3.—NO-VOLTAGE RELEASE, CIRCUIT-BREAKER AND ENCLOSED RHEOSTAT.

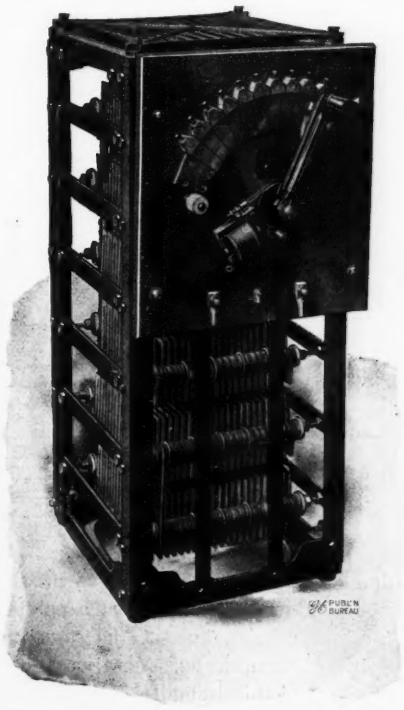


FIG. 4.—MACHINE TYPE, RA SPEED-REGULATING RHEOSTAT, FLOOR STYLE.

If controlling rheostats of this type are operated where chips are apt to fly from the work, a cover for entirely enclosing the front can be furnished. An insulated sprocket-wheel or gear can also be supplied so that the controller can be mounted in any desired location. Fig. 3 shows one of these regulating rheostats enclosed in iron casings complete, with circuit-breaker equipped with no voltage release.

For the second class of motor-speed control, as above mentioned, the General Electric Company manufactures a type of rheostats known as the machine type RA (Figs. 3 and 4). This line of rheostats is designed for controlling the speed of shunt or compound-wound motors from one-eighth to twenty horse-power at 125, 250 and 500 volts direct current. Larger sizes are furnished when desired. In this

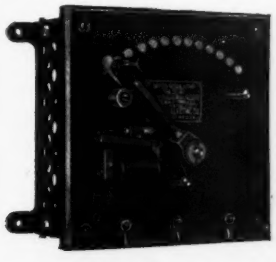


FIG. 5.—MACHINE TYPE, RA SPEED REGULATING RHEOSTAT, WALL STYLE.

type a speed reduction of fifty per cent under normal full-load conditions and twenty-five per cent at full-load can be obtained by inserting resistance in the armature circuit. Nine divisions of resistance are provided in these regulators, so that ten different motor speeds may be obtained. In the smaller sizes the resistances are wound on tubes, while in the larger capacities cast-iron grids are used. These rheostats will carry currents corresponding to twenty-five per cent overload on the motor without injurious heating.

Aside from the points mentioned, this latter type of controller has several especially desirable features. It is equipped with a no-voltage coil connected in series with the shunt fields, so that if the voltage fails or the shunt field of the motor be broken the contact-arm returns automatically to the starting position and stops the motor. When this no-voltage coil is enlarged the tension of a band-brake around the base of the switch is increased and holds the contact-arm in whatever position it is left. This method of holding the contact-arm in any position is simple and very durable, as the tension on the band-brake can be easily adjusted for wear. For the smaller capacities the switch-arm is mounted on the top, while in the larger sizes it is mounted on the sides of the box as shown in the illustrations.

4,500-Horse-Power Gas-Power Plant in Cement Works.

The Iola Portland Cement Company, Iola, Kan., has recently placed an order with the Westinghouse Machine Company, of East Pittsburg, Pa., for three 500-horse-power, horizontal, double-acting gas engines and one 125-horse-power, vertical, single-acting gas engine to increase the capacity of its already large gas-power plant. The three horizontal gas engines now on order will be the first of this type to be installed in the power-house, the remainder being of the vertical type. After the installation of the engines now on order, the power equipment will comprise fifteen engines of the Westinghouse vertical, single-acting type and three of the horizontal, double-acting type, aggregating about 4,500 horse-power. The company operates its plant upon Kansas natural gas-fuel, and is one of the largest users of gas power in the cement manufacturing field.

The exports of copper for the first ten months of 1905 amounted to 208,510 tons, against 205,594 tons for the same period in 1904.—*Copper Gossip.*

A Novel Water Hoist.

The question of unwatering a mine always is a serious problem to the mine management, especially so when the water is highly impregnated with acids. When the amount becomes excessive the means to be employed for disposing of it taxes the ingenuity of all concerned to the uttermost.

In the anthracite regions there are mines in which for every ton of coal raised as high as fourteen tons of water must be pumped, and this must be done at a minimum of expense. Nowhere, probably, have a greater variety of pumps and lifting devices been tried—and the most satisfactory type, up to date, for handling large quantities of water at comparatively low heads have proved to be large boilers operated by steam engines. These, however, lack the mechanical regularity inherent in a pump, as they are necessarily operated by men, and it remained for the Delaware, Lackawanna & Western Railroad Company and its electrical engineer, H. M. Warren, to finally develop a water-hoisting equipment which would preserve all the valuable points of the steam hoist, and at the same time operate automatically. The carrying out of the mechanical details of the hoist and its automatic devices were confided to the Wellman-Seaver-Morgan Company, of Cleveland, Ohio, and the successful operation of the plant reflects great credit on the latter, as it guaranteed the machinery to accomplish the desired results. Most of the electrical controlling devices were furnished by the Electric Controller and Supply Company, of Cleveland, Ohio. In the original specification the Delaware, Lackawanna & Western Railroad Company called for the hoist to be operated by an alternating-current motor of 800 horse-power, and the question of starting, stopping and reversing so large a motor had, at the outset, to be met. The duty to be performed by the hoist called for the raising of 4,000 gallons of water per minute to a height of 550 feet.

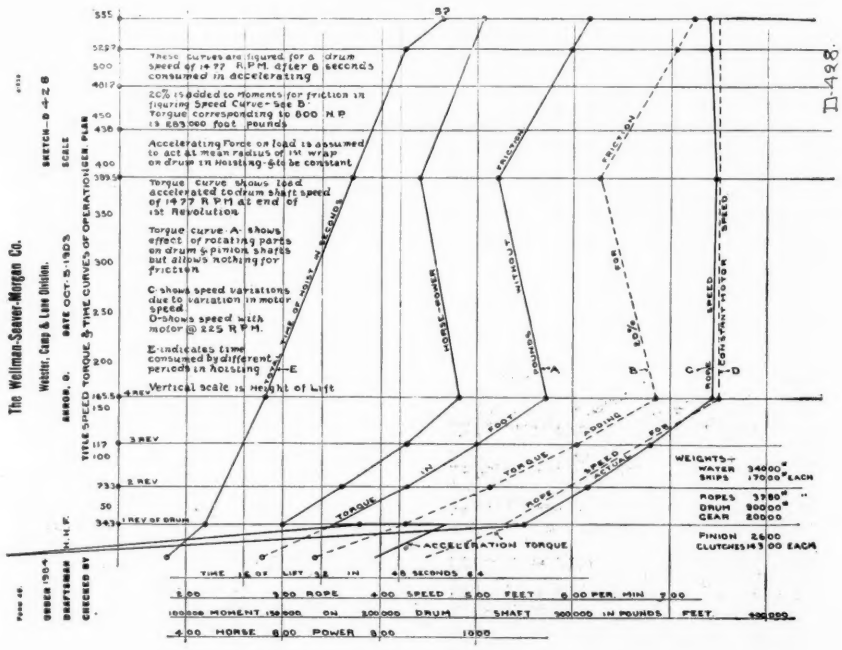
		Pounds.
4,000 gallons	× 8.27 =	33,180
550 ft. of 2-in. rope	× 6.3 =	3,465

36,645 pounds to be raised at 550 feet per minute.

$$\frac{36{,}645 \times 550}{33{,}000} = 610 \text{ net horse-power.}$$

Weight of bucket equals one-half weight of water, so that weight on rope equals 53,235 pounds or nearly twenty-seven tons, requiring two-inch steel rope.

The various preliminary speed and movement diagrams are laid out per accompanying diagram:


The Wellman-Seaver-Morgan Co.
D-498
These curves are figured for a drum speed of 14.77 R.P.M. after 8 seconds consumed in accelerating
20% is added to moments for friction in figuring Speed Curve - See B
Torque corresponding to 800 H.P. is 683,000 foot pounds
Accelerating Force on load is assumed to act at mean radius of 1st wrap on drum in Hoisting - & to be constant
Torque curve shows load accelerated to drum shaft speed of 14.77 R.P.M. at end of 1st Revolution
Torque curve A shows effect of rotating parts on drum & pinion shafts but allows nothing for friction
C shows speed variations due to variation in motor speed
O shows speed with motor @ 225 R.P.M.
E indicates time consumed by different periods in hoisting
Vertical scale is Height of Lift
WEIGHTS—
WATER 34000#
SHIPS 17000# EACH
ROPES 3780#
DRUM 80000#
GEAR 20000
PINION 2600
CLUTCHES 1300 EACH
ACCELERATION TORQUE
TIME IN SECONDS
ROPE
SPEED
FEET PER MIN
MOMENT ON DRUM SHAFT IN POUNDS FEET
HORSE POWER

It was decided in carrying out the design that it would be impracticable to design the hoist other than have a motor running continuously in one direction, as it is a well-known fact that the amount of current required to accelerate a large motor of this type is enormous, and greatly interferes with the proper running of the power plant.

The company desired to use an alternating-current motor directly at the hoist, and as the motor was to run continuously

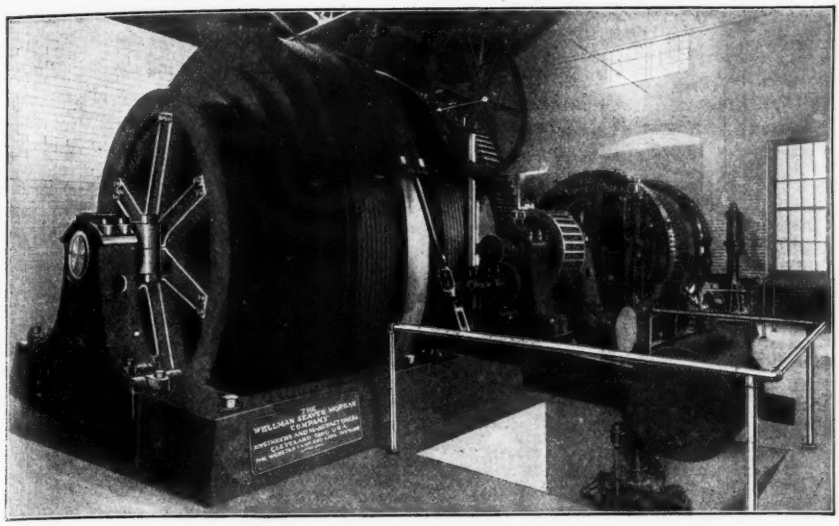


FIG. 1.—FRONT VIEW OF ELECTRICALLY DRIVEN WATER HOIST.

in one direction this necessitated the use of friction clutches for accelerating and reversing the load.

As the Wellman-Seaver-Morgan Company had several smaller plants already in operation using alternating-current motors on hoists, which are operated similarly to the present hoist, and as they are running successfully, and the repairs and renewals for clutches had not exceeded that required for the other hoisting engines, it was decided to use this method.

Fig. 1 and Fig. 2 show a front and side view of the hoist. As will be noticed the general arrangement consists of a motor driving a pair of bevel wheels through a single-bevel pinion. The bevel wheels run loose on a shaft and are fitted with the well-known Webster, Camp & Lane friction clutches. The operating mechanism for the clutches are so designed that only one clutch can be thrown in at a time, but both clutches can be out at the same time. Throwing in one clutch runs the drum in one direction; throwing in the other clutch reverses the motion of the drum.

To the shaft on which the bevel wheels run is keyed a pinion meshing with main gear on the drum shaft. The drums are of the cylindro-conical type, ten feet at the small diameter and sixteen feet at the large diameter. At a hoisting speed of 550 feet per minute the drum makes about fifteen revolutions per minute. There is one main brake located between the drums. All of the clutches and brakes

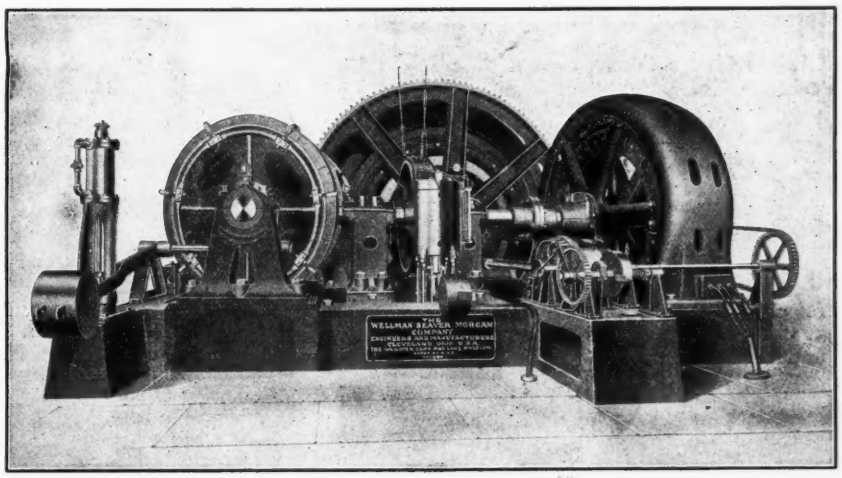


FIG. 2.—SIDE VIEW OF ELECTRICALLY DRIVEN WATER HOIST.

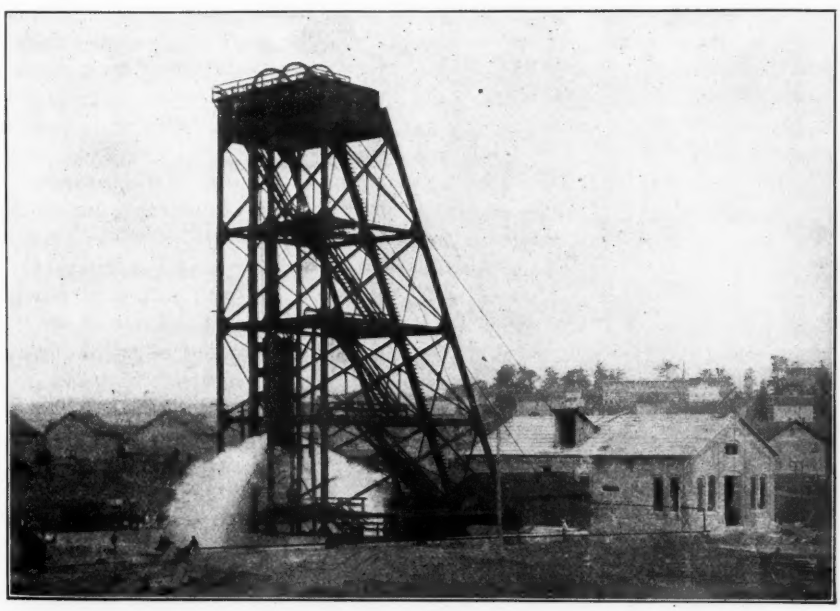


FIG. 3.—HEAD FRAME OF ELECTRICALLY DRIVEN WATER HOIST.

are operated by auxiliary air cylinders fitted with oil-cushion cylinders, the compressed air being furnished by a motor-driven air-compressor and the necessary tanks located near to the hoist. The hoist is controlled by a mechanical device shown in Fig. 2. This device consists mainly of a drum rotated by means of a friction drive from the motor through a sprocket-chain. The drum-shaft transmits its motion to a secondary shaft fitted with variable speed, which in turn operates a secondary stop. The main hoisting drum-shaft operates a traveling nut, which is so located with respect to the controller drum that at either end of its travel it releases a stop and allows the controller drum to make a quarter turn; this movement, through suitable electrical connections, operates the solenoids on the clutch valve, releasing the clutch, and the solenoid on the brake valve setting the brake, the further movement of

the controlling drum being arrested by the secondary stop. This stop is released by the variable-speed shaft and its connections, which has been given a predetermined time movement corresponding to the interval for emptying the bucket. The further movement of the controlling drum releases the brake and throws in the reversing clutch, thus starting the hoist in the opposite direction, and also starting the traveling nut on the controlling mechanism in the opposite direction. At the end of the hoist the cycle of controlling movement is repeated and so on, making the hoisting operation continuous and automatic. Every attention has been given to the safe operation of the hoist. The main brake is of the gravity type and to be released the current must be on the solenoid operating the valve so that air can be admitted to the underside of the brake piston.

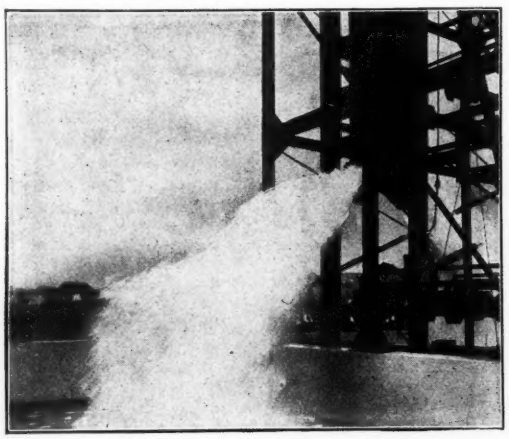


FIG. 4.—DISCHARGE OF BUCKET, ELECTRICALLY DRIVEN WATER HOIST.

If for any reason, either the supply of current or of air-pressure is interrupted, the valve drops, and the weights on brake lever set the brake. The clutches are designed so that they are thrown out by weights. As is the case with the brake, either clutch can only be thrown in when the current is on the solenoid, and the air pressure admitted under the piston, and if either current or pressure fail, the clutch is off. The motor-shaft is fitted with an emergency-brake operated by a weight controlled by a solenoid—any interruption in the flow of current to the motor sets the brake and stops the motor. Any interruption of the flow of the currents stops the machine, throws out the clutches and puts on the brake. A safety cutout is provided for in the head frame, so that in case a bucket is carried beyond the proper height the current is cut off. Fig. 3 shows the head frame. The head frame is ninety-three feet from the base to the centre of the sheave at the top. It is built of structural steel, roughly in the shape of an "A." From the head frame are suspended two buckets six feet in diameter and nineteen feet six inches deep. The capacity of each bucket is seventeen tons of water. In the bottom of the bucket are located two lift gates with an area practically equal to the cross-section of the bucket.

These gates are lifted automatically when the bucket reaches the top, and the water is discharged through the bottom into a spout fitted below the bucket, and which deflects it to either side of the shaft. Each bucket makes a complete round trip in one minute and fifty seconds, the total lift being 555 feet. Fig. 4 shows a nearer view of the bucket when discharging.

The New Sangamo Alternating-Current Meter.

The new Sangamo type "D" integrating wattmeter illustrated herewith has been placed upon the market after a number of years of experiment, both in the use of mercury in meters of various kinds and also on the several details involved. The meter works upon new principles in alternating-current measurement, and owing to its design and construction it has been found possible to eliminate practically all chance of trouble from jewel wear or bearing friction, and at the same time to develop a meter with high torque, great accuracy on all loads, large over-load capacity and the ability to work accurately with shunts of any capacity.

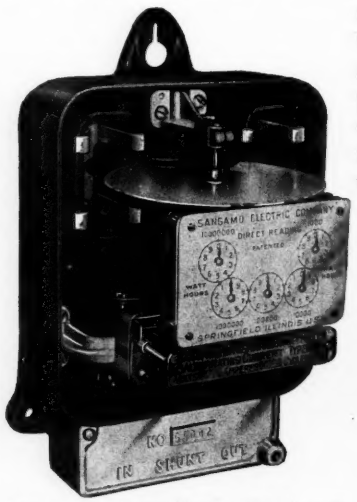


FIG. 1.—SANGAMO TYPE "D" ALTERNATING-CURRENT WATTMETER.

The method of operation of the meter on alternating current is very interesting. In series with the shunt coil of the meter, which is carried on a laminated iron yoke, shown in Fig. 1 at the lower part of the meter, is a condenser, readily accessible if it is desired to remove it. This condenser has the effect of changing the phase of current in the shunt coil in such a way as to bring the magnetism of the shunt field in phase with the pressure on the circuit to which the meter is connected. The main current passing to the load goes directly through the copper disc armature, shown in Fig. 2, and which is completely enclosed in the mercury-tight insulating chamber, somewhat similar to the mercury chamber of the type "C" (direct-current) Sangamo meter, which is now well known. The current is led in and out from the disc chamber by means of contact ears on each side, which can also be seen in Fig. 1.

The passage of the load current across the strong shunt magnetic field causes rotation of the armature, the motion being transmitted to the recording train in the usual manner. The armature spindle or shaft, as shown in Fig. 2, projects through a ring-shaped sapphire jewel set in the upper cover of the mercury chamber, which is formed in such a way that no mercury can get out, no matter in what position the meter is turned. The upper end of the armature shaft proper keys freely into an external shaft or spindle which carries the aluminum damping disc, shown at the top of the meter in Fig. 1. This outer shaft also has on it the worm for driving the recording train, this being underneath the disc so that the worm-wheel is well protected from accidental injury.

FIG. 2.—COPPER DISC ARMATURE.

The adjustment of the meter on light load is obtained in a manner similar to that used in the Gutmann meter (manufactured by the Sangamo Company), by means of a small soft iron piece slid back and forth on the face of one of the shunt field poles just below the disc chamber; the movement of this piece gives a wide range of adjustment on light load.

The adjustment for speed is obtained by moving a small soft iron disc above the upper poles of the two magnets facing each other, this disc being carried on a fine pitch screw, working in the bracket above. The shunting of more or less lines of force between the upper poles of the two magnets and away from the

disc gap below causes a wide variation in the damping effect, and consequently great ease of speed adjustment. The insulating chamber in which the armature and mercury is carried is formed of a special material, which long experimenting has proved to be durable at very high temperature, and this and the laminated magnet structure are carried from the base of the meter by one large screw at the centre and four smaller ones at the side, which being removed allow the entire working part of the meter to be taken out of the base with the least possible trouble.

In case the shunt coil itself should be injured from any cause, it can be removed and replaced very easily, as it is carried on a laminated yoke held by the two lowest screws in the laminated magnet structure.

The method of eliminating friction and wear on the bearings is probably the most interesting point about this meter, except the use of the condenser to obtain the necessary torque. The armature, as shown in Fig. 2, has a dome or closed cup form at the centre, this constituting an air-float when the armature is immersed in mercury.

There is no jewel bearing, and in fact, no bearing in a true sense inside the disc chamber at the bottom of the armature spindle, there being simply a soft steel guide at this point for holding the shaft laterally. At the top the shaft presses upward against a carefully selected flat sapphire jewel, the proportioning of the float on the armature being such that this thrust does not exceed thirty to thirty-five grains.

The top bearing is adjusted by a micrometer screw and is set so that the end-shake between the top bearing and the spindle can not exceed a little over 0.01 inch.

The type "D" meter is accurate on inductive loads, down to low power-factors, and the adjustment for inductive load is obtained in somewhat the same way as the light load adjustment and can be quickly made.

The drop through the series element of the meter is small, as there are no series windings. In a ten-ampere, 100-volt meter the drop between binding-posts is claimed to be not over 0.02 volt at full load. In larger capacity meters, where a part of the current is shunted across the binding-posts, the drop through the disc is increased by means of resistance wire in series with it, so as to eliminate the effect of variation in the joints of contacts, either in the shunt across the binding-posts or in the disc circuit.

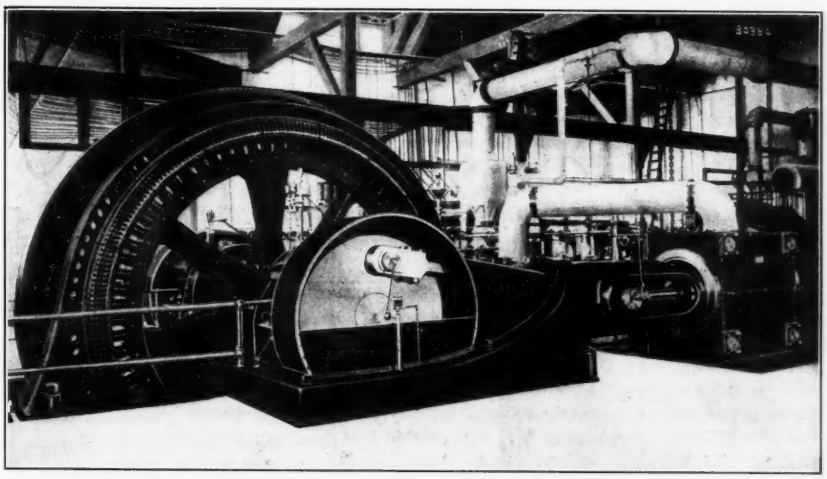
The manufacturer states that the drop between posts in meters from twenty to sixty amperes capacity will not exceed 0.08 to 0.10 volt. Sizes from eighty amperes and upward are shunted externally in the same manner as the type "C" Sangamo meter for direct current. The shunt loss is small and the torque is very high, being about the same as in the better class of induction meters now on the market, making a high ratio of torque to weight on the bearings.

The curve of the meter is good, the variation from one-thirtieth load to twenty-five per cent overload not exceeding two per cent total. On variations in voltage, the meter holds its accuracy over a wide range, is accurate for ordinary variations in frequency and is not appreciably affected by change in temperature. It is easy to readjust one of the meters for a different frequency than that for which it was originally calibrated, any adjustment desired can be made with great facility and speed. The meter is of the same size and general appearance as the type "C" Sangamo meter and weighs, complete with glass case, eleven pounds.

For three-wire work the meters are made with small series transformers properly constructed so as to measure the total power on both sides of the system. The meter is manufactured by the Sangamo Electric Company, Springfield, Ill., and is also sold by its general selling agent, the Electric Appliance Company, Chicago, Ill.

New Municipal Electric Lighting Plant.

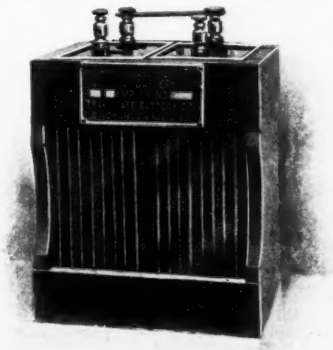
The city of Alpena, Mich., which recently voted an issue of bonds to defray the cost of a municipal lighting plant, has contracted with Allis-Chalmers Company, Milwaukee, Wis., for the complete electrical and power equipment. This consists of a sixty-cycle Bullock alternating-current generator, normal capacity 150 kilowatts, direct-connected to a Reynolds-Corliss cross-compound heavy-duty engine; an exciter unit; jet condenser; switchboards; substation apparatus, and equipment for 100 arc lamps connected in series. A feature of this installation will be its compactness, as provision has been made for the future enlargement of the plant, when the growth of the city demands it, by an extension of the existing building and the addition of another generating unit.



Municipal Lighting Plant at Owensboro, Ky., Showing an Allis-Chalmers Generating Unit Similar to That Contracted for the City of Alpena, Mich.

A Tray Plate Spark Battery.

The Tray Plate Battery Company, Binghamton, N. Y., has placed on the market a spark battery, built on the principle of construction which has made the tray plate battery so popular within recent years. The company states that these batteries have given excellent service for sparking, and that a three-cell spark storage battery of this construction averaged over 2,800 miles on one charge, and that it can be recharged at an expense of not over twenty-five cents. The voltage of this storage battery, it is stated, remains constant at two volts per cell until totally discharged.



Tray Plate Spark Battery.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

ELECTRIC PLANT FOR ALL OF LONDON—The London (England) county council has decided to introduce a bill in Parliament, under which the council will construct a plant to supply all the electrical energy for London and its suburbs, at a cost estimated at $40,000,000.

PLANS FOR POWER PLANT AT MONTEREY, MEXICO—A. W. Liliendahl, it is announced, has under way a plan to establish a hydraulic plant to supply electricity to the city of Monterey, Mexico. It is understood that a canal will be built from the head of the Pilon river to the power-house site, and the water utilized, so that a high head will be available. A stone power-house, 100 feet by 150 feet, will be erected. Engineers are now at work arranging for preliminary surveys.

TELEPHONE PLANS CONSUMMATED—The Indianapolis telephone deal, by which Toledo and St. Louis syndicates secured a majority of the stock in the new Independent Telephone Company for $700,000, has been closed. C. E. Stinson, formerly manager of the Home plant in Toledo, Ohio, has taken charge of the Indianapolis property, together with its long-distance lines. Temporary certificates have been issued of the underwriting and a voting trust has been established. The trust now controls more than ninety per cent of the stock. New certificates will be issued in about thirty days.

THE ST. JOSEPH & KANSAS CITY ELECTRIC RAILWAY—Derrison, Prior & Company, of Cleveland, through their Boston main financial office, and Thomas Nevins & Sons, of New York, are placing $2,500,000 of the unsold portion of the $5,000,000 underwriting of the Missouri Valley Electric Railway Company securities with eastern capitalists and New York and New England investors under their recent offerings for subscriptions. They state the company has been duly organized under the laws of Missouri, with full legal powers and franchises to construct and operate a high-speed electric railway on private rights of way from Kansas City to St. Joseph. It is expected the entire $2,500,000 will be placed in a short time.

LEHIGH VALLEY TRANSIT COMPANY EFFECTS REORGANIZATION—Having finally received its charter, which had been held up on a technicality for three months, the stockholders of the Lehigh Valley Transit Company met last week in the offices of Brown Brothers, Philadelphia, Pa., and effected a reorganization, with Colonel H. C. Trexler, of Allentown, as president. The properties included in the reorganization are those of the old Lehigh Valley Traction Company—the Philadelphia & Lehigh Valley Traction Company, the Allentown & Slatington Street Railway Company and the Coplay, Egypt & Ironton Street Railway Company. At a meeting of the directors held subsequently, E. M. Young was elected vice-president; John C. Dawson, of Philadelphia, temporary secretary and treasurer; Warren S. Hall, of Allentown, general manager, and C. M. Walters, of Allentown, auditor.

MUNICIPAL OWNERSHIP SUCCESSFUL AT BROCKVILLE, ONTARIO—The report of the commissioners of the municipal light and power department for the year ending September 30, just issued, shows a satisfactory condition of affairs. The gas revenue was $25,257.96 and the receipts from electric current $15,707.10, against $18,145.32 and $12,448.06 respectively in 1900-01, when the works were taken over by the town. Every account owing the department of gas and electric current for the past year has been collected with the exception of $6. The profits for the year, after deducting $2,448.70 for depreciation on plant, paying interest due on debentures and all other expenses, amount to $6,508.27. Since the works have been taken over by the town the consumers of gas and electricity have paid into the department $26,685.89 more than it has taken to run the works, after paying interest on debentures and all other expenses in connection therewith, as well as writing off $5,082.22 for depreciation of plant. This $26,685.89 to the credit of the profit and loss account at this date is not an available profit, as the department has handed over $23,598.30 to reduce the lighting works debenture debt, which leaves an available surplus of $3,087.59 in the hands of the commissioners. The operation of the plant by the town has given satisfaction. Besides reducing the debenture debt each year out of the earnings of the department, meeting running expenses and the cost of installing much new valuable machinery, the consumers of gas and electricity have nearly doubled and the price of gas and electricity has been reduced. In the five years of municipal ownership the bad debts of the department total the sum of $66.30.

ELECTRIC LIGHTING.

ROCKMART, GA.—The election for bonds for electric lights resulted in favor of the issue.

BALTIMORE, MD.—The Havre de Grace electric light plant is being enlarged and a 150-horse-power boiler installed.

LITTLE ROCK, ARK.—S. C. Dowell, of Walnut Ridge, proposes to establish a $25,000 electric light plant at Pocahontas.

WILLIAMSPORT, PA.—The Jersey Shore Electric Company will enlarge its power-house, and a new unit will be installed.

ROSLYN, N. Y.—The North Hempstead town board has granted the petition of taxpayers of Lakeville for the erection of a lighting district.

NEW LONDON, CT.—Fort Mansfield, at Napatree point, is to have a system of electric lights and electrical connections for other purposes.

NORTH BAY, ONT.—The by-law voted on at New Liskeard to establish waterworks and electric light systems was defeated by a vote of 930 to 37.

MEDWAY, MASS.—The Kendall Construction Company has completed the work of rebuilding the lines of the Medway Electric Light and Power Company.

JACKSONVILLE, FLA.—Contracts for the purchase of two 500-kilowatt electric generators for the Jacksonville electric lighting plant have been awarded by the board of bond trustees.

AMERICUS, GA.—The city council has awarded the contract for lighting the streets and residences of Americus with electricity and for pumping waters to the American Gas and Electric Company.

SUSSEX, N. J.—A majority of the stockholders of the Consumers' Light and Power Company, of Middletown, voted recently to sell the company's plants to the Orange County Light and Power Company for $65,000.

LITTLE FALLS, N. Y.—At an adjourned regular meeting of the Little Falls common council a franchise was granted to the Hudson River Electric Power Company to operate in Little Falls for a term of fifty years.

HARRISBURG, VA.—The Blue Ridge Light and Power Company has purchased from the Virginia Power Corporation what is known as the Nicholas water power on North river just west of Port Republic.

BUFFALO, N. Y.—The referendum in favor of having the people vote on the proposition of having a municipal electric light plant was carried by 5,741. The affirmative vote was 7,691 and the negative vote 1,950.

LA CROSSE, WIS.—The La Crosse Gas and Electric Company has issued notice to its consumers of electricity that beginning December 1, 1905, the price of electric current will be seven and one-half cents per kilowatt-hour, instead of ten cents.

AMERICAN FORK, UTAH—The Utah County Light and Power Company is planning to construct a duplicate of its canyon plant, about two miles above the present location. The cost will be in the

neighborhood of $60,000. The company is almost entirely owned by the three cities of American Fork, Pleasant Grove and Lehi, and has been successful since it commenced operation, about five years ago.

QUINCY, ILL.—The Quincy city council has entered into a three-year contract with the Quincy Gas and Electric Company. The contract calls for 336 street lamps, at $54.40 each per year, and twelve lights in Washington park, at $40 each.

GREENWOOD, IND.—The Citizens' Water and Light Company has reorganized with D. E. Demott, J. A. Craig, J. W. Henderson, W. M. Carson, C. B. Cook, Harvey Brewer and A. W. Owens, directors. The purchase of the old plant was provided for.

WASHINGTON, N. J.—The plant of the Washington Electric Light Company has been purchased by A. B. Beadle, of New York, and M. A. Maxwell, of Easton. The consideration was $24,800. A considerable sum will be expended in improvements.

MISSOULA, MONT.—The Missoula Light and Water Company is preparing to install considerable new machinery and to make substantial improvements at its power plant at Bonner. The principal of these will be the addition of a 750-horse-power turbine.

BRISTOL, TENN.—An electric light company has been organized at Bluff City, with J. D. Haun, president; W. E. Wolfe, vice-president, and J. H. Bachman, secretary and treasurer. The company will light Bluff City and the farm-houses of that community.

TEMPLE, TEX.—The town of Killeen, twenty-five miles west of Temple on the Santa Fe railway, is to have electric lights, a local company having been organized for the purpose. The town has about 1,000 inhabitants and already has a telephone exchange and waterworks, owned by local capital.

RITZVILLE, WASH.—The Ritzville Electric Light and Power Company, now owned and controlled by O. H. Greene, will soon pass into the hands of a Seattle company. The consideration is $45,000, and it is said that the new company will invest about $15,000 in improvements during the coming year.

NEW ALBANY, MISS.—The board of aldermen of New Albany, at its regular December meeting, will probably issue $12,000 of town bonds, the proceeds of which will be expended in enlarging the city light plant and in improving the streets. New Albany's new light plant, which is owned and operated by the city, is proving a success.

WICKFORD, R. I.—At the annual meeting of the Wickford Light and Water Company the following officers were elected: president, T. F. I. McDonnell; vice-president, Louis F. Bell; secretary and treasurer, Thomas J. Peirce; directors, T. F. I. McDonnell, Louis F. Bell, Andrew Radel, E. W. Shedd, Albert Gregory, Robert F. Rodman, T. J. Peirce.

GLENS FALLS, N. Y.—At the postponed annual meeting of the United Gas, Electric Light and Fuel Company the following were elected directors: C. P. Wentz, G. L. Wentz and Dr. J. L. Wentz. The directors organized by electing the following officers: C. P. Wentz, president; G. L. Wentz, vice-president; Dr. J. L. Wentz, treasurer; H. Monteath Collin, secretary and general manager.

WEIR CITY, KAN.—The property of the Weir City Light and Water Company in Weir City has been transferred to the Central Coal and Coke Company. The property transferred includes the water and light plant and most of the other real estate owned by the company. The following officers were elected: president, Tom Mackie; vice-president, F. E. Doubleday; secretary and treasurer, Charles Sweeney.

GEORGETOWN, CAL.—It is stated that the Waldorf Mining and Milling Company will install an electric light plant at Georgetown. A force of men has been put to work constructing a ditch for the purpose of turning the waters out of west Clear creek. As soon as the waters have been diverted the company will start work on a big dam which will store water for power purposes. A pipe-line will be run to the Glenn mill site, located near the high bridge of the Colorado & Southern Railroad, at which place a power plant of large capacity will be constructed. The water will have a fall of 400 feet in 600 yards.

ENGINEERING SOCIETIES.

MADISON (WISCONSIN) BRANCH OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—The November meeting of the Madison branch of the American Institute of Electrical Engineers was held on Thursday evening, November 16, at the rooms of the Doherty Electrical Club, Chairman Scott presiding. The subject of "Lightning Protection" was discussed to a considerable extent. The papers presented at the last New York meeting of the Institute were abstracted by J. B. Kommers and R. A. Wheeler. The discussion was opened by Mr. F. E. Fisher.

NEW PUBLICATIONS.

UNIVERSITY OF IOWA—The engineering society of the University of Iowa has issued vol. x of the "Transit," the annual publication of that society. This contains a number of interesting papers, though none of them is upon a distinctly electrical subject.

REPORTS TO THE SECRETARY OF THE NAVY—The following annual reports to the secretary of the navy have been issued: that of the paymaster-general; that of the surgeon-general; of the judge-advocate-general, and the superintendent of library and naval war records.

THE YEAR BOOK OF LEGISLATION, NEW YORK STATE LIBRARY—The digest of governor's messages for 1904 has been assembled in attractive book form, with a review of legislation in 1904, and published by the New York state education department of the New York State Library, Melville Dewey, director. The work has been edited by Robert H. Whitten, sociology librarian. The book is handsomely bound in buff cloth, and contains, in addition to the text, a glossary and index.

THE EXPORTERS' ENCYCLOPÆDIA—The Exporters' Encyclopædia, second edition, contains shipping instructions in detail for every country in the world. The names and addresses of transportation companies, both steam and sail, from New York, Philadelphia, Boston, Baltimore, New Orleans, Galveston, and other ports, are arranged separately for each country. Explanations are given concerning bills of lading, arrangements of consular documents, charges, requirements of the different foreign governments; and instructions are given concerning the packing, marking and shipping and the insuring and consigning of shipments. The encyclopædia is published by the Exporters' Encyclopædia Company, 65 Duane street, New York city, at $3 per copy.

THE ELECTRICAL TRADES' DIRECTORY AND HANDBOOK FOR 1906—The twenty-fourth edition of the Electrical Trades' Directory and Handbook is in preparation, and will be ready for distribution January, 1906. This "Big Blue Book" contains a carefully compiled list of British, colonial and foreign electricians, electrical engineers, electric light and power and electric railway and tramway engineers and contractors. There are lists of apparatus makers, electrochemists and electrometallurgists, electrical manufacturers, supplying corporations; and each branch of the art is the subject of a considerable amount of statistical data. In addition to this there are numerous useful tables and data relating to the industry, and a biographical section with portraits, giving interesting particulars of the careers of about 300 eminent men connected with electricity in all its applications.

PROCEEDINGS OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION—The proceedings of the National Electric Light Association for the twenty-eighth convention, held at Denver and Colorado Springs, Col., June 6 to 11, 1905, have been published by order of the executive committee. Vol. i contains papers, reports and discussions, and vol. ii the question-box and "wrinkles." The size of these publications is constantly increasing, and their value to an engineer's library is making the same advance. The books are finely printed and substantially bound in the customary green baize cover. The typography and press work is from the house of the James Kempster Printing Company, New York city, and shows up in the usual handsome style. The association has issued a booklet setting forth a list of a limited number of papers and reports which are available in pamphlet form. Prices may be had on application to the secretary, W. C. L. Eglin, 136 Liberty street, New York city.

TELEPHONE AND TELEGRAPH.

COTTON PLANT, MISS.—A new telephone branch line has been built to Orizaba.

LITTLE ROCK, ARK.—The Sharp County Telephone Company has completed a line to Center.

TROY, N. Y.—The Hudson River Telephone Company has made connections at Johnsonville with the Easton Telephone Company.

COLUMBUS, OHIO—The People's Telephone Company, of Mt. Blanchard, Hancock County, has increased its capital stock from $50,000 to $100,000.

WAYNESBURG, PA.—Papers have been executed by which the South Penn Telephone and Telegraph Company, of Waynesburg, passed into the hands of the Bell company.

ALVIN, TEX.—A local telephone line from the Mill Crossing neighborhood has been completed to Alvin. The line will be extended to Sandy Point and possibly to Angleton.

ARLINGTON, N. J.—The New York & New Jersey Telephone Company, which recently received a franchise in North Arlington, is making preparations for the construction of its lines in that borough.

DENVER, COL.—A report issued by the Colorado Telephone Company shows that it now has nearly 44,000 subscribers, an increase of 7,000 since the first of the year. The gross earnings for the year were $1,497,350.

OAKLAND, CAL.—The Sunset Telephone Company has commenced the work of removing its overhead wires in the business district and placing them in conduits, under the provisions of a recent ordinance.

MILWAUKEE, WIS.—It is stated that the South Side exchange of the Wisconsin Telephone Company will be greatly enlarged during the winter. A new exchange is to be established at St. Martin's to cover the Hale's Corners territory.

ALBANY, N. Y.—The Independent Union Telephone Company will erect a two-story long-distance exchange within the next month or so. Ground will be broken for the new building at once and the structure will be rushed to completion. It will cost $15,000.

JERSEY CITY, N. J.—Officials of the New York & New Jersey Telephone Company have announced that beginning November 1 the rate from pay stations in Jersey City and Hoboken to other stations, public and private, will be reduced from ten to five cents for each call.

ATTICA, N. Y.—A franchise has been granted the Inter-Ocean Telephone and Telegraph Company by the trustees of the village of Arcade to construct and maintain a telephone exchange in that village. The telephone company agrees to install, without expense to the village, a fire-alarm system.

CLEVELAND, OHIO—The directors of the Federal Telephone Company chosen at the recent meeting at East Orange, N. J., have elected the following officers: president, Frederick S. Dickson; first vice-president, Edward W. Moore; second vice-president, Charles W. Wason; secretary, James B. Hoge; treasurer, R. W. Judd.

DAVENPORT, IOWA—At a meeting of the Long Grove Mutual Telephone Company the following officers were elected: president, R. K. Brownlie; vice-president, Leonard Litscher; secretary and treasurer, G. B. Maxwell. This company will operate lines from Long Grove to McCausland, Eldridge, Donohue, Noel's Station and Dixon.

EVANSVILLE, IND.—At a meeting of the directors of the Pocket Long-Distance Telephone Company, recently organized in Huntingburg, the following officers were elected: president, Allen Gray, Evansville; vice-president, R. N. Parrett, Princeton; treasurer, Henry Landgrebe, Huntingburg; secretary, H. C. Rothert, Huntingburg. The work of connecting the various independent lines of southern Indiana will be pushed forward during the coming winter. It is the purpose of the new company eventually to obtain a franchise in Evansville and connect that city with its lines.

ELECTRIC RAILWAYS.

MANKATO, MINN.—The franchise of the Mankato & St. Peter Railway and Lighting Company has been extended to February 12, 1906.

ITHACA, N. Y.—The transfer of the Cayuga Heights Electric Railway to the Ithaca Street Railway Company has been made under a ninety-nine-year lease.

SOUTH BEND, IND.—At the annual meeting of the Indianapolis, Logansport & South Bend Traction Company, the following officers were elected: S. S. Perley, president; H. J. Crismond, vice-president; E. P. Taylor, secretary; V. Nicar, treasurer.

MIDDLETOWN, MD.—The directors of the Frederick-Middletown Electric Railway Company have elected James E. Ingram, Jr., of Baltimore, president and J. Roger McSherry, of Frederick, vice-president. It was decided to establish repair shops in Frederick.

SIOUX CITY, IOWA—Announcement has been made that the Sioux City & Ireton Interurban Railway Company will build its line from Sioux City to Ireton. It is proposed to issue $400,000 of five and one-half per cent twenty-year bonds. The plan is eventually to continue the line to Spirit Lake. Surveyors are now at work laying out the route.

STREATOR, ILL.—The People's Railway Company and the Streator Gas and Light Company, two large corporations, have been merged. The recently incorporated Illinois Light and Traction Company was the purchaser. The latter corporation is capitalized at $400,000, and in addition to extending local lines will build an interurban road connecting Streator and Ottawa.

DANBURY, CT.—The Danbury & Harlem Traction Company has perfected arrangements for the immediate resumption of work on the trolley line which it has partially constructed between Danbury and Golden's Bridge, N. Y. Work will begin on the section between Ridgebury and North Salem. It is expected that the road will be ready for public traffic between Danbury and North Salem early next spring and to Golden's Bridge by summer.

ASBURY PARK, N. J.—The property, franchises, etc., of the Atlantic Coast Electric Railway Company, which system extends from Pleasure Bay to Sea Girt, have been sold in foreclosure proceedings. The purchaser was Adrian H. Joline, of the law firm of Butler, Notman & Joline, New York, and the price $700,000. The property is believed to have been bought in for H. H. Rogers, as preliminary to winding up the receivership of former Senator James Smith.

LINCOLN, NEB.—The Falls City, Sycamore Springs, Sabetha & Southwestern Railway Company, an organization recently formed for promotion purposes, has filed articles of incorporation. The plans of the company were made public some time ago. It is purposed to build a line of road from Falls City to Sycamore Springs and Sabetha, Kan. The capital stock is $100,000. The incorporators are: J. H. Miles, George Boone, Jr., E. H. Towle, W. E. Dorrington, George L. Campen, Samuel Kimmel, W. A. S. Bird, H. Reding, E. V. Kauffman, Albert Maust, Ray Hesseltine, J. E. Wallace, Charles McGuire, E. S. Towle, W. H. Crook.

SAN FRANCISCO, CAL.—The General Electric Company has obtained the contract to equip the Ocean Shore Railway Company, which plans to build an electric railway from San Francisco to Santa Cruz, seventy-five miles. The contract includes all power-station apparatus, 160 car motors of 125 horse-power each and all accessories. The line is to be double-track. The power-house will be built at Balboa on Halfmoon bay. The boiler plant will include five 600-horse-power Babcock & Wilcox boilers. Wheeler condensing apparatus will be installed and all auxiliaries will be steam-driven. The furnaces will be provided with improved oil-burning apparatus.

EDUCATIONAL.

UNIVERSITY OF ILLINOIS—The University of Illinois Club of New York city will hold its second annual dinner and reunion at the Hotel Vendome, Saturday evening, December 9. A good number of former students and instructors of the University have promised to attend, and some interesting addresses are anticipated. Further information may be obtained from Mr. S. T. Henry, 317 West Fifty-sixth street, New York city.

PERSONAL MENTION.

MR. LUTHER R. FOLLEY has been appointed assistant inspector of gas and electric light for the city of London, Ontario.

MR. CHARLES H. SIMPSON has received the appointment as manager of the Batavia, N. Y., office of the Western Union Telegraph Company.

MR. IRWIN LEHMAN, who for some years represented the Columbia Incandescent Lamp Company in Texas, has joined forces with the Westinghouse Electric and Manufacturing Company in the interest of the Sawyer-Man lamp in Texas.

MR. JOSEPH SACHS, whose name has been for a long time intimately connected with the development of enclosed fuses, has severed his connection with the Johns-Pratt Company, Hartford, Ct., and becomes president of a new organization to be known as the Arknot Company, Hartford, Ct.

MR. J. J. NATE, Minneapolis, Minn., the northwestern agent of the Stromberg-Carlson Telephone Manufacturing Company, will make a trip to Chicago early in December to be present at the fiftieth wedding anniversary of his parents, the Rev. and Mrs. John Nate, 1819 North Sawyer avenue. The anniversary will occur on December 6. Last summer Mrs. Nate spent a portion of the season in Minneapolis with her son.

MR. CHARLES Y. McVEY has been appointed general manager of the Federal Telephone Company, with headquarters at Cleveland, Ohio. Mr. McVey went to Cleveland from Youngstown, where he had been connected with a local telephone company. He was promoted to the position of assistant general manager of the Federal company some time ago. In his new capacity he will exercise a general oversight of the work of the United States Telephone Company.

PRESIDENT WILLIAM H. BLOOD, of the National Electric Light Association, has reappointed the committee on rates and costs which made a report to the Denver convention. This committee consists of Messrs. Charles L. Edgar, chairman; Louis A. Ferguson, Samuel Scovil, Frank W. Frueauff, P. G. Gossler and R. S. Hale. Mr. George W. Brine, who was a member of the committee last year, has had occasion to decline, on account of illness, to serve again this year.

MR. CYRUS O. BAKER, says the Newark (N. J.) *Evening News*, has recently completed a handsome residence in East Orange, N. J. He has purchased a homestead adjoining, and will have the grounds artistically laid out by a landscape gardener, making the property one of the most attractive in the city. Mr. Baker is a director of the National State Bank, of Newark, and has for a long time been prominent in electrical and financial circles. For years he has been an active member of the National Electric Light Association, and has been an extensive traveler, visiting many fields in the interests of the platinum supply of the world, of which material his company is the largest importer of the present day.

MR. J. S. LEHMAN.

MR. J. S. LEHMAN, a well-known incandescent lamp salesman, has joined forces as one of the general lamp salesmen of the Sawyer-Man Electric Company, New York city, and has been assigned to the St. Louis office. Mr. Lehman entered the incandescent lamp field in 1893 as cashier and bookkeeper of the Columbia Incandescent Lamp Company, St. Louis, Mo. Four years later he was placed in charge of all the city business, which he handled successfully until 1899, when he was transferred to Texas, spending the following three years in that state as well as in Louisiana and Mexico. In 1902 he was recalled to St. Louis and assigned to the western territory, including the Pacific coast. He continued in that territory until November 1, 1905, when he entered the employ of the Westinghouse Electric and Manufacturing Company as general lamp agent for the Sawyer-Man Electric Company.

ELECTRICAL SECURITIES.

With the return of monetary ease there was a very great activity displayed in the stock market last week. Prices in almost every line made substantial advances but this is held to be due to professional manipulation, and has not attracted the public interest that was looked for. Notwithstanding the dubious attitude of the bear following and the discouraging tone of the advice emanating from commission houses, there is apparent an unabated industrial boom in all quarters. Car shortages, overtime in many industries, and advancing dividends are the points upon which the optimist is relying for the fulfilment of the rosy prognostications made earlier in the summer. Iron and steel are still in great demand and with copper prices at a higher level than in some time the demand is reaching record proportions.

ELECTRICAL SECURITIES FOR THE WEEK ENDING NOVEMBER 25, 1905.

New York:	*Closing.*
Brooklyn Rapid Transit	88
Consolidated Gas	179¾
General Electric	188⅜
Interborough Rapid Transit	210
Kings County Electric	200
Manhattan Elevated	163
Metropolitan Street Railway	119⅞
New York & New Jersey Telephone	150
Westinghouse Manufacturing Company	190

The annual stockholders' meeting of the Metropolitan Street Railway Company will be held December 4, at 12 o'clock noon.

For the first twenty days of November the gross earnings of the Brooklyn Rapid Transit Company increased $6,000 per day, as compared with an increase of $5,750 per day during October, and $5,250 per day during September.

Directors of the General Electric Company have recommended that the new stock recently authorized be offered to stockholders on the basis of 12½ per cent of their holdings at par.

Boston:	*Closing.*
American Telephone and Telegraph	136¼
Edison Electric Illuminating	245
Massachusetts Electric	57
New England Telephone	134
Western Telephone and Telegraph preferred	89

Philadelphia:	*Closing.*
Electric Company of America	11½
Electric Storage Battery common	80
Electric Storage Battery preferred	80
Philadelphia Electric	8½
Philadelphia Rapid Transit	32⅝
United Gas Improvement	92¾

Philadelphia Rapid Transit earnings during October were very large, the gross showing a gain of $94,000 over the same month last year. This is the largest increase of any month during the present fiscal year.

Chicago:	*Closing.*
Chicago Telephone	137½
Chicago Edison Light	161
Metropolitan Elevated preferred	70½
National Carbon common	80
National Carbon preferred	115
Union Traction common	11½
Union Traction preferred	37

OBITUARY NOTICE

MR. CHARLES A. THOMPSON died on the evening of Monday, November 27, as the result of a fractured skull, sustained from a fall on last election day. He had not regained consciousness from the time of his injury until his death. Mr. Thompson was forty-four years of age, and had been an active worker in the electrical field for the past twenty-five years. He was born in Elkhart, Ind., and received his early electrical training from Dr. J. J. Wood of the Fort Wayne Electric Works. He was superintendent of the old Manhattan Electric Light Company, in New York city; had been associated with the Stanley Electric Manufacturing Company, at Pittsfield, Mass.; superintendent of the Winston-Salem Electric Light Company, Winston-Salem, N. C.; president of the Thompson-Bonney Company, Brooklyn, N. Y., and president of the Charles A. Thompson Company, of New York. He was widely known and highly respected in the electrical field and his death will be deeply deplored.

INDUSTRIAL ITEMS.

THE CHICAGO PNEUMATIC TOOL COMPANY, Fisher Building, Chicago, Ill., is distributing catalogue No. 18, describing and illustrating rock drills and parts.

THE JANDUS ELECTRIC COMPANY, Cleveland, Ohio, is moving into new and more commodious office and manufacturing quarters, though it remains in the same building in which it has been located for the past few years.

THE SAMSON CORDAGE WORKS, Boston, Mass., announces the removal of its office to 88 Broad street, Broad Exchange Building, where it will have better and larger facilities for taking care of its continually increasing business.

THE WESCO SUPPLY COMPANY, St. Louis, Mo., through the Live Wire Publishing Company, distributes an attractive monthly designated as "The Live Wire." This contains considerable literature concerning new features of electrical supplies.

THE C. W. HUNT COMPANY, West New Brighton, Staten Island, N. Y., has issued catalogue No. 058. This describes the Hunt steam-hoisting engines. These engines are unusually massive in construction, and are designed especially for heavy duty in continuous service.

THE NATIONAL ELECTRIC COMPANY, Milwaukee, Wis., has issued two bulletins, Nos. 359 and 363, illustrating and describing, respectively, polyphase induction motors and stationary and portable motor-driven air-compressors, for continuous and intermittent service.

THE STANDARD WELDING COMPANY, Cleveland, Ohio, has issued a booklet illustrating and describing its manufacture of standard seamless steel rings. These rings are made for chucks, gears, blanks, pails and poles from Bessemer, open-hearth or crucible steel, copper, brass and bronze stock, rolled and welded by electricity.

THE MONARCH ELECTRIC MANUFACTURING COMPANY, Warren, Ohio, reports a very brisk demand for the Monarch lamp The company makes the "Monarch Standard" and the "Monarch Special." These lamps are guaranteed by the maker to give a brilliant, steady light, and to maintain a great length of life with a low current consumption.

THE JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, has recently established a New England branch, with offices in the Oliver Building, 141 Milk street, Boston, Mass. Mr. H. C. Freeman, for many years at the home office at Columbus, will be engineer in charge. Catalogues, price lists and specifications covering the Jeffrey complete line may be had by addressing Mr. Freeman at this office.

S. H. COUCH COMPANY, INCORPORATED, Boston, Mass., in booklet No. 9 describes the automatic reset or switchless intercommunicating telephone. Sectional views and wiring diagrams are given, showing in detail the mechanical and electrical features. The company has also published several other catalogues describing telephones, switchboards and accessories, any or all of which may be secured upon request.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., and Chicago, Ill., has issued a dainty booklet bearing the inscription "For Your Perusal at Leisure." This contains a number of high-class testimonials concerning the use of Stromberg-Carlson intercommunicating systems. There are illustrated portable desk telephones, central energy wall telephones, intercommunicating portable desk telephones, and a private branch exchange switchboard with a capacity of sixty lamp signal lines and ten trunk lines.

THE NORTHERN ELECTRICAL MANUFACTURING COMPANY, Madison, Wis., has published leaflet No. 148, showing some of the applications of Northern motors in hoisting-work. The company is making a box type of machine especially designed to meet the requirements of hoisting-work. These are built with exceptionally sturdy shafts and liberal bearings. The motors are built with bosses, which can be drilled and tapped for fastening to the machine to be driven or supplied with feet so that the equipment can be mounted under any conditions. Box-type motors are built dustproof, and frequently supplied for use out of doors without requiring any special protection against weather and rain except that embodied in the machine design.

THE ARKNOT COMPANY, Hartford, Ct., has been organized with Mr. Joseph Sachs as president, to do a general business in small electrical appliances and accessories including devices such as those with which Mr. Sachs's name has been connected for years. It is expected that the company will have a complete line of National Electric Code standard enclosed fuse appliances ready for the market in the near future, and also a number of allied specialties. Mr. Sachs is the well-known inventor of many forms of enclosed fuse devices. Mr. Sachs is no longer connected with the Johns-Pratt Company, Hartford, Ct., the manufacturer of the enclosed fuse devices invented and developed by him.

THE BANNER ELECTRIC COMPANY, Youngstown, Ohio, is now moving into its new factory which has been under construction during the past spring and summer. This new "Banner" building is well located for light and good air and is a most intelligently planned and excellently constructed factory. Four or five floors of the building are entirely devoted to incandescent lamp-making, though the entire lower floor will be used by the Specialty Manufacturing Company in the production of switches, bells and other electrical specialties. The offices are large and especially attractive, and are planned so as to be en suite for the personnel of the sales and technical organizations.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., announces the establishment of an industrial engineering department, in which is concentrated all its work in the line of industrial engineering as applied to railway shops, machine shops and industrial plants of every description. J. K. Warner Davenport, E. E., formerly a consulting engineer, making a specialty of industrial work, has become associated with the company in order that its growing activities along these lines may be handled in as thorough and satisfactory a manner as heretofore. Mr. Davenport and his staff of assistants are at the present time giving personal attention to several important industrial propositions. Among those who have availed themselves of the services of the Crocker-Wheeler Company in this line are the Lake Shore & Michigan Southern Railroad, John Simmons Company, Bucyrus Company, Ansonia Brass and Copper Company, American Bridge Company, Pittsburg & Lake Erie Railroad, Joseph Dixon Crucible Company and Ingersoll-Sergeant Drill Company.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., has been awarded the contract by the Metropolitan Water and Sewerage Board, of Boston, Mass., for pumping apparatus for the Arlington waterworks station. The equipment to be furnished by the Allis-Chalmers Company, includes a horizontal, compound, condensing pumping engine, having a capacity of 1,500,000 United States gallons in twenty-four hours, against a head of 290 feet. This engine is one of a new line of small horizontal engines recently designed by the Allis-Chalmers Company, to replace pumping engines of the direct-acting type. Three centrifugal pumps, each having a capacity of 10,000,000 gallons, have been secured from the company for the Massapequa pumping station of the Brooklyn (N. Y.) waterworks. Mr. George H. Norman, president of the Newport waterworks, Newport, R. I., has awarded contracts for a vertical, triple-expansion crank and flywheel pumping engine to the Allis-Chalmers Company, the engine to have a daily capacity of 6,000,000 United States gallons, against a head of 190 feet.

THE PEERLESS ELECTRIC COMPANY, Warren, Ohio, in the current issue of "The Pigeon-Hole," a monthly publication distributed by the company, presents several illustrations of electrically driven laundry machinery. A recent development is a Peerless motor direct-connected to an extractor, which a number of the foremost manufacturers of laundry machinery have adopted. The Peerless company has recently made a number of individual motor installations, including a motor equipment for the planing mills of Wallace Brothers, Mahoningtown, Pa.; the Lawrence Lumber Company, Newcastle, Pa., and the Bagley & Sewel Company, Watertown, N. Y. Individual motors have also been installed for the Hayworth Publishing House, Washington, D. C.; fifteen motors for Eaton-Hurlburt Company, Pittsfield, Mass., and sixty-two motors for the plant of the Sherman Envelope Company, Worcester, Mass. Peerless high-frequency, alternating-current generators for laboratory use have been ordered by Cornell University and by Joseph Murgas, of Wilkesbarre, Pa. The State University of Iowa has placed orders for laboratory transformers and motors, and the Massachusetts Institute of Technology has given an additional order for Peerless machines.